

A re-examination of the genus *Cheilanthes* (Adiantaceae) in Australia

T.C. Chambers and P.A. Farrant

Abstract

Chambers, T.C. & Farrant, P.A. (Royal Botanic Gardens, Sydney, NSW, Australia) 2000) 1991. A re-examination of the genus *Cheilanthes* (Adiantaceae) in Australia. *Telopea* 4(3): 509–557. The taxonomy of the Australian species of *Cheilanthes* has been further revised following the availability of a much greater number of specimens, especially from northern Australia, since the revision of this genus in Australia by Quirk et al. in 1983. We describe one new species (*C. adiantoides*) and recognise 14 other species, one of which has two subspecies. Two of the 15 taxa recognised by Quirk et al. are reduced to synonymy. We clarify the taxonomy of the northern Australian species, and recognise one of the four species described recently by D.L. Jones. Two of the three taxonomic changes proposed by P.S. Green in 1988, one new combination and one change of authority, are accepted. Scatter diagrams are used to compare characters of specimens in what are believed to be closely related taxa. The distribution of each species is mapped and a key for their identification provided. The diagnostic characters found to be most useful for separating the Australian *Cheilanthes* were the degree of frond division, and the length and density of hairs and scales, on stipe, rachis and upper and lower pinnule surfaces; spore characters were useful for some but not for all species. Although the breeding behaviour of *Cheilanthes* was not investigated per se in this study, new data on variability in spore number and spore size suggest that both hybridisation and apomixis are occurring in some populations and variation from hybridisation is contributing to the difficulty of defining some species.

Introduction

Examination of a much wider range of specimens from Australian herbaria, as well as specimens from elsewhere (including many type specimens), has enabled us to further revise the taxonomy of the Australian species of *Cheilanthes*, following on from the publication of Quirk et al. (1983). One new species is described (*C. adiantoides*) and fourteen other species are recognised, one of which (*C. sieberi*) has two subspecies. Of the fifteen taxa recognised by Quirk et al. (1983), two (*C. shirleyana* and *C. nudiuscula*) have been reduced to synonymy (with *C. tenuifolia* and *C. hirsuta* respectively), while one of the two Species Dubiae in Quirk et al. (1983) (*C. prenticei*) is recognised, and the other (*Cheilanthes* sp.) is placed in *C. caudata*. Only one (*C. praetermissa*) of the four new species described by D.L. Jones (1988) is accepted, and Jones' new combination of *C. pseudovellea* is not accepted. Of the three taxonomic changes proposed by P.S. Green (1988), one new combination (*C. nitida*) and one change of authority (for *C. brownii*), are accepted. The change of name proposed for *C. sieberi* is not substantiated.

The cytology of *Cheilanthes* was not further investigated. Nevertheless, the spore numbers in the sporangia (16 and 32) and the spore sizes (very large in the case of the 16-spored sporangia) are strong evidence of obligate apomixis occurring widely in the Australian species of *Cheilanthes*. The 32-spored sporangia may be the result of the 'normal' type 'Döpp-Manton' sequence (see Walker 1979 for discussion) where after four mitotic divisions of the archesporium, in one of which the cells fail to divide, eight spore mother cells are produced; the subsequent meiotic divisions result in 32-spored sporangia. The 16-spored sporangia contain 16 large spores as well as 16 minute aborted spores, suggesting that an uneven division is taking place. Four taxa,

Cheilanthes sieberi subsp. *sieberi*, *C. caudata*, *C. pumilio* and *C. brownii*, exhibit both 32- and 16-spored individuals. This suggests a complex pattern of evolution that is not fully understood at present.

The genus *Cheilanthes* has been variously placed in the Polypodiaceae (Christensen 1906), the Pteridaceae (Copeland 1947), the Sinopteridaceae (Pichi-Sermolli 1970, 1977), and the Adiantaceae (Mickel 1987). We have accepted that *Cheilanthes* belongs to the Adiantaceae.

Neurosoria, a monotypic genus created by Mettenius in 1869 for a single Australian species which he had removed from *Acrostichum*, cannot be separated from *Cheilanthes*. *A. pteroides* was placed in the genus *Cheilanthes* by Quirk et al. (1983) under *C. tenuissima* (*C. nitida* in this paper). The genus *Cheilanthes* appears to be closely allied to the genus *Notholaena*. *Cheilanthes fragillima*, for example, originally described by Hooker as *Notholaena fragilis*, has sori not sufficiently confluent to place it in *Notholaena*. *Notholaena* is now considered to be an American genus, with no representatives in Australia (Tryon & Stolze 1989). Two species of *Cheilanthes* in Australia (*C. nitida* (R. Br.) P.S. Green and *C. praetermissa* D.L. Jones) superficially resemble species in *Mildella* (*M. leonardii* and *M. intramarginalis*), a genus not found in Australia. Some authors (Tryon & Stolze 1989) place *Mildella* in synonymy with *Cheilanthes*. Comparison of *Cheilanthes* from Australia with American specimens of *Mildella*, however, indicates that the two genera are distinct. *Cheilanthes nitida* and *C. praetermissa* do not possess either the marginal flange or the inframarginal indusium characteristics of the genus *Mildella*. *Cheilanthes praetermissa* also bears a superficial resemblance to *Doryopteris concolor* (Langsd. & Fischer) Kuhn; *Doryopteris*, however, is characterised by a simple or palmatifid lamina.

We have only included synonyms based on Australian types in this publication. Full synonymies can be found in Quirk et al. (1983). Full details for specimens cited in the figures can be found under 'Selected Specimens' of the appropriate taxon; all such specimens are from NSW unless otherwise indicated.

Diagnostic characters

Identification of Australian species of *Cheilanthes* is not always easy. A 10x hand lens will not usually be powerful enough for examining the hair and scale characteristics and certainly is not adequate for spore characteristics or counts. The dendritic nature of some hairs and scales, for example, can only be observed by removing and examining individual hairs or scales under a dissecting microscope. The diagnostic characters that were found to be most useful for the Australian *Cheilanthes* were length and density of hairs and scales, on stipe, rhachis and upper and lower pinnule surfaces, and the degree of frond division; spore characters were useful for some, but not all, of the species. The hair and scale distribution for upper and lower pinnule surfaces and for stipe or rhachis, for each Australian taxon, is shown in Figures 1–4. The salient characters of the Australian taxa are summarized in Table 1. As well, many useful figures, including figures of type specimens, will be found in Quirk et al. (1983).

The hairs found on the Australian species of *Cheilanthes* are of two forms: simple hairs, i.e. elongate unbranched (most species, see Figures 17d, 19e) or, rarely, with a single branch (Figure 13j); and multi-branched hairs, i.e. dendritic compound trichomes (only in one species, *C. lasiophylla*, see Figure 18f). The hairs vary in length, from minute (< 0.2 mm) to short (0.2–0.5 mm) to medium (0.5–1.0 mm) to long (> 1.0 mm). The hairs vary in rigidity and this is not dependent on their length, for example the minute hairs of

C. contigua, the short hairs of *C. tenuifolia* and *C. contigua* and the medium to long hairs of *C. fragillima* are all rigid. Apart from these species, however, the rigidity of hairs may not be consistent even on any one specimen. The hairs on *Cheilanthes* vary in straightness: the rigid hairs tend to be straight, long weak hairs tend to curl and can form a dense tangled mass as in *C. brownii*, while the hairs of *C. sieberi* subsp. *pseudovellea* are quite twisted. Rigid straight hairs tend to be erect, while weak hairs tend to be spreading. Glandular hairs are found on several species (Figure 13j). Hairs may have blunt apices or they may taper to a point. Hairs are usually uniseriate, though occasionally they may be two cells broad at the base. Scales have multiseriate bases and taper to an apex, sometimes with protuberances along their margins (Figures 13e, 17e, 19f); in one species, *C. lasiophylla*, the scales have dendritic bases (Figure 18g). In some species the scales are densest at the junctions of stipe, rachis and rachillas (Figure 1d).

The range of hair density found in the Australian *Cheilanthes* can best be seen on the following figures: absent/glabrous (Figure 1c), sparse (Figure 2a), moderately dense (Figure 2c), and dense (Figure 4b). Hairs may be denser at the margins (Figure 3d).

Spores

Scanning electron micrographs of spores of all the Australian *Cheilanthes* species are presented in Figures 5–8.

All spores examined in this study were from herbarium specimens. Sporangia were selected from sori which appeared mature. Spores were mounted on double-sided sticky tape on stubs, coated with gold in a sputter coater and examined under a scanning electron microscope. All spores were photographed at the same magnification and measured along their diameter (round spores) or across the surface in line with one of the axes of the trilete mark (tetrahedral spores). Measurements of single spores from different specimens (and different collections) were used in calculating average spore size for a species.

The spore sizes reported in this study indicate some differences from those given by Quirk et al. (1983). In both studies the spores were measured from scanning electron micrographs. Differences in the lower limit of the spore size given in the two publications are probably the result of minor differences in the maturity of spores (although seemingly mature sporangia were chosen for both studies). In general the upper limit of the spore size has been extended in this new study because of the greater range of specimens available. In the case of several species there is significant new information on the spores.

C. sieberi subsp. *sieberi*. Although Quirk et al. (1983: 519) gave two spore size ranges for this species, they omitted to mention that these two groups have different spore counts: plants either have 32 smaller spores per sporangium (Figure 5c,d) or 16 larger spores per sporangium (Figure 5a,b).

C. sieberi subsp. *pseudovellea*. Although the scale on the micrograph of the spore in Quirk et al. (1983: Figure 37) gives the correct size, the spore size of 32 μm diam. in the text (1983: 522) is in error. This subspecies has large verrucate spores, with an average diameter of 60.6 μm ($n=33$ spores) (Figure 5e).

C. fragillima. Both the spore size range of 22–25 μm diam. and the number of spores per sporangium (16) given by Quirk et al. (1983: 525) are incorrect, although the spore micrograph scale gives the correct spore size (Figure 39 in Quirk et al.). Most specimens of this species have spores already shed, and so these figures may reflect a

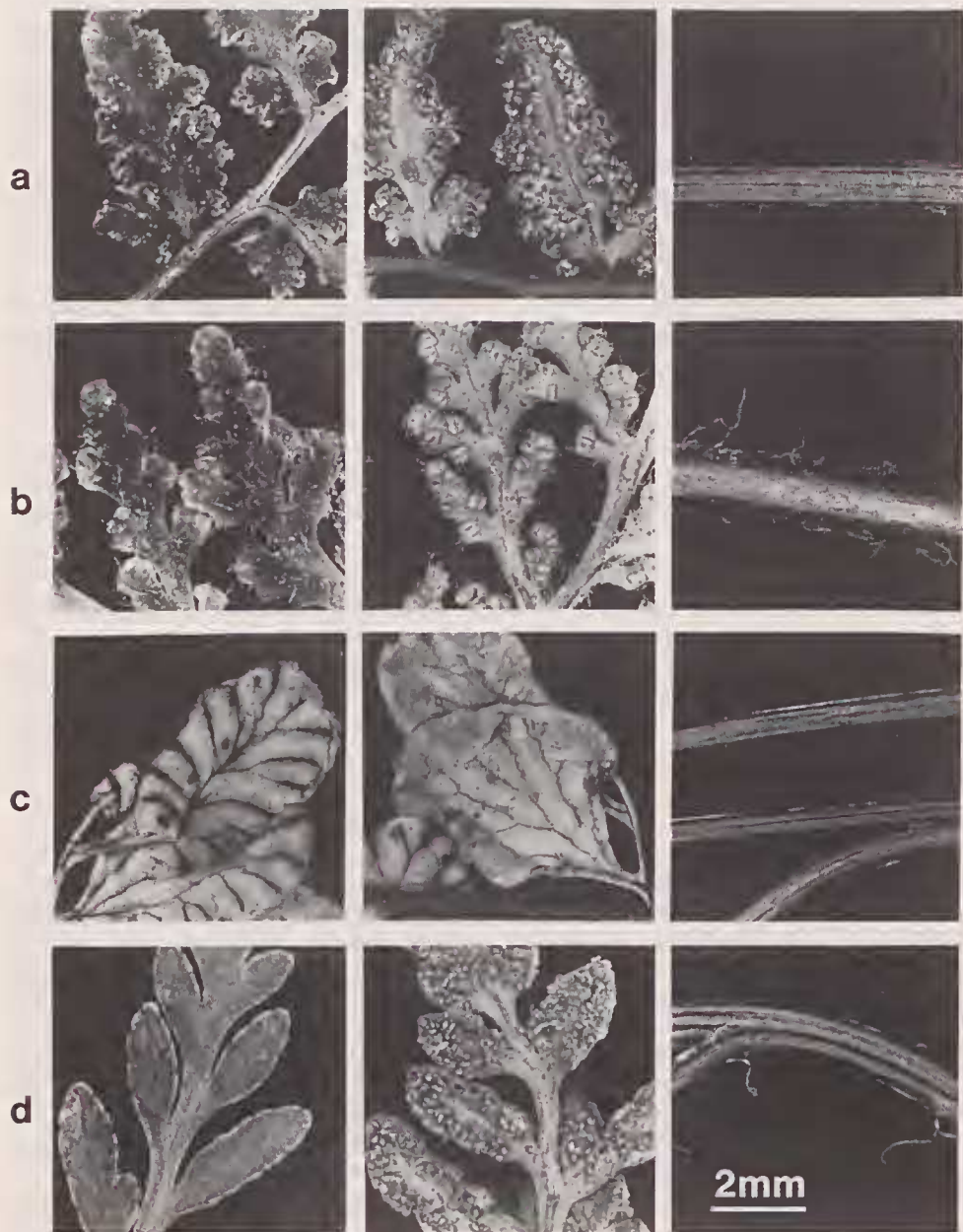


Figure 1. Hair and scale characteristics of *Cheilanthes* species (all from specimens in NSW) from left to right: upper (adaxial) pinnule surface, lower (abaxial) pinnule surface and stipe; all to same scale: a, *C. sieberi* subsp. *sieberi*: upper and lower pinnule surfaces: Boorman, NSW 192555; stipe: Beaglehole 20266; b, *C. sieberi* subsp. *pseudovellea*: upper and lower pinnule surfaces: Nelson 1745; stipe: Coveny 544; c, *C. adiantoides*: Chinnock 5274; d, *C. austrotenuifolia*: upper and lower pinnule surfaces: Helms, NSW 192117; stipe: Wilson 1870.

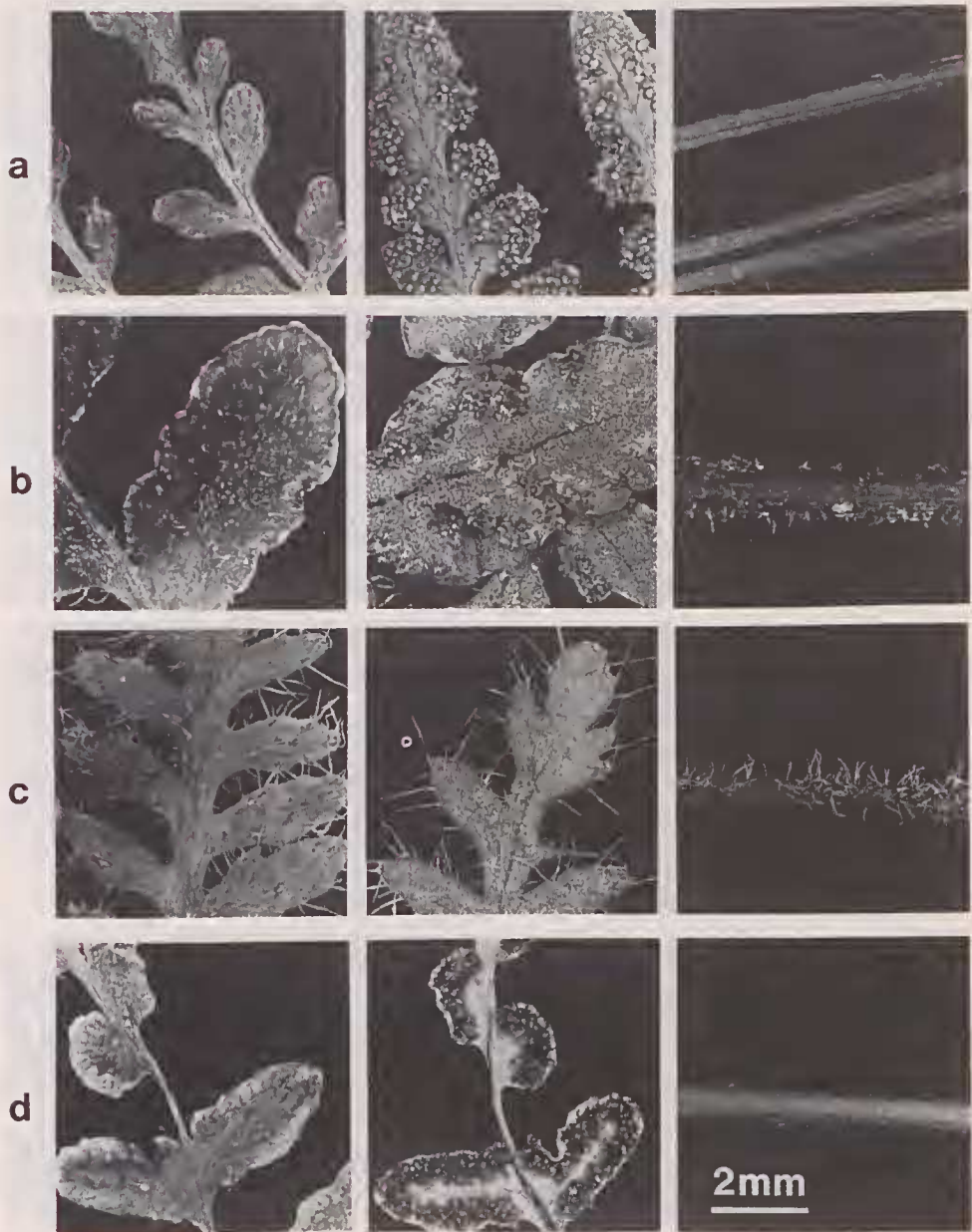


Figure 2. Hair and scale characteristics of *Cheilanthes* species (all from specimens in NSW): upper (adaxial) pinnule surface, lower (abaxial) pinnule surface and stipe (a, b, d) or rhachis (c); all to same scale: a, *C. tenuifolia*: upper pinnule surface and stipe: Messmer, NSW 192452; lower pinnule surface: Waller, NSW 199183; b, *C. contigua*: Brown, NSW 199026; c, *C. fragillima*: Pullen 9443; d, *C. caudata*: Jones 1549.

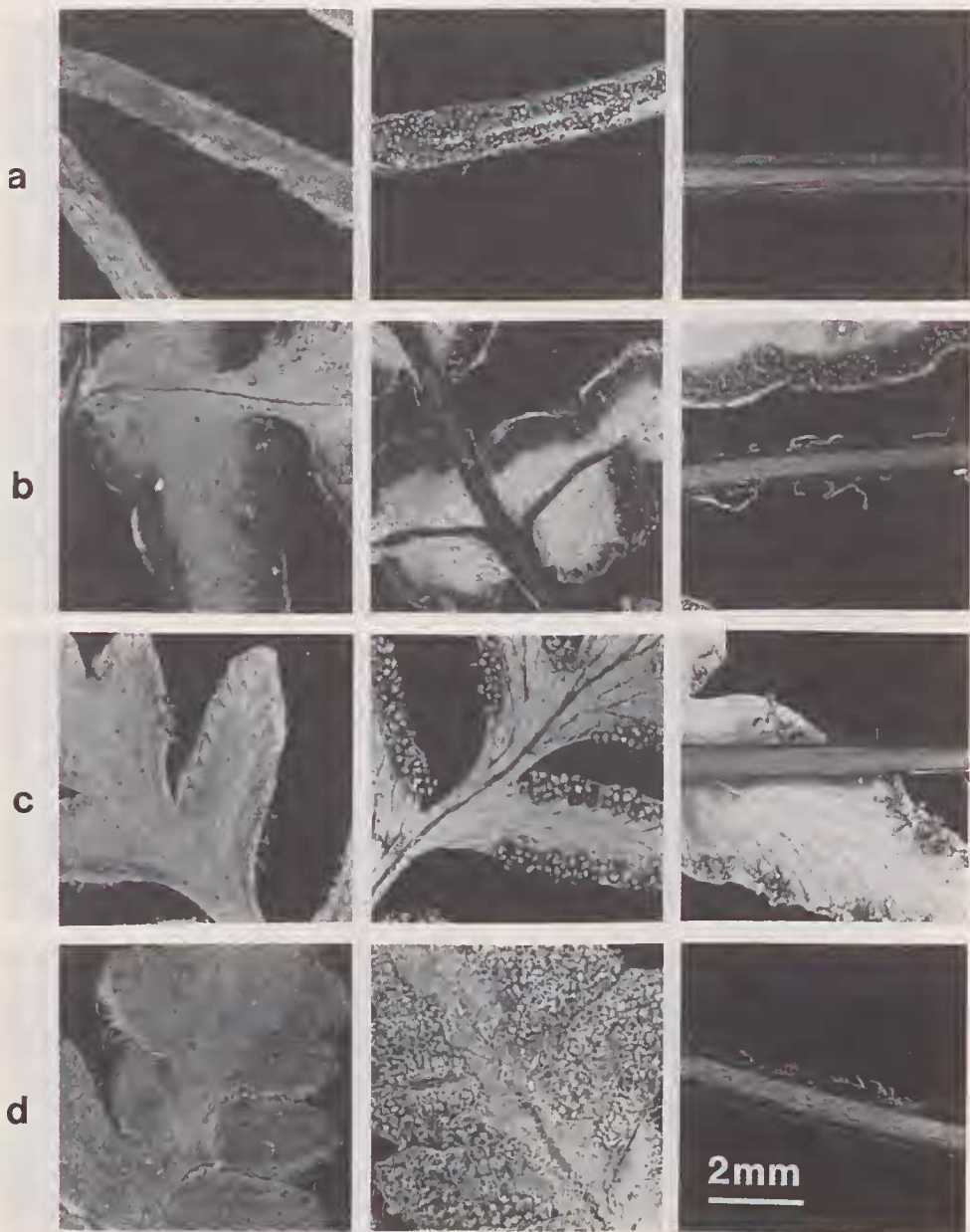


Figure 3. Hair and scale characteristics of *Cheilanthes* species: upper (adaxial) pinnule surface, lower (abaxial) pinnule surface and stipe; all to same scale: a, *C. nitida*: McKee 9271; b, *C. praetermissa*: M. Lazarides 7876; c, *C. pumilio*: Tindale 6054; stipe: Wood R790396a; d, *C. prenticei*: upper and lower pinnule surfaces: Tate, BRI 314663; stipe: Young, BRI 314659.

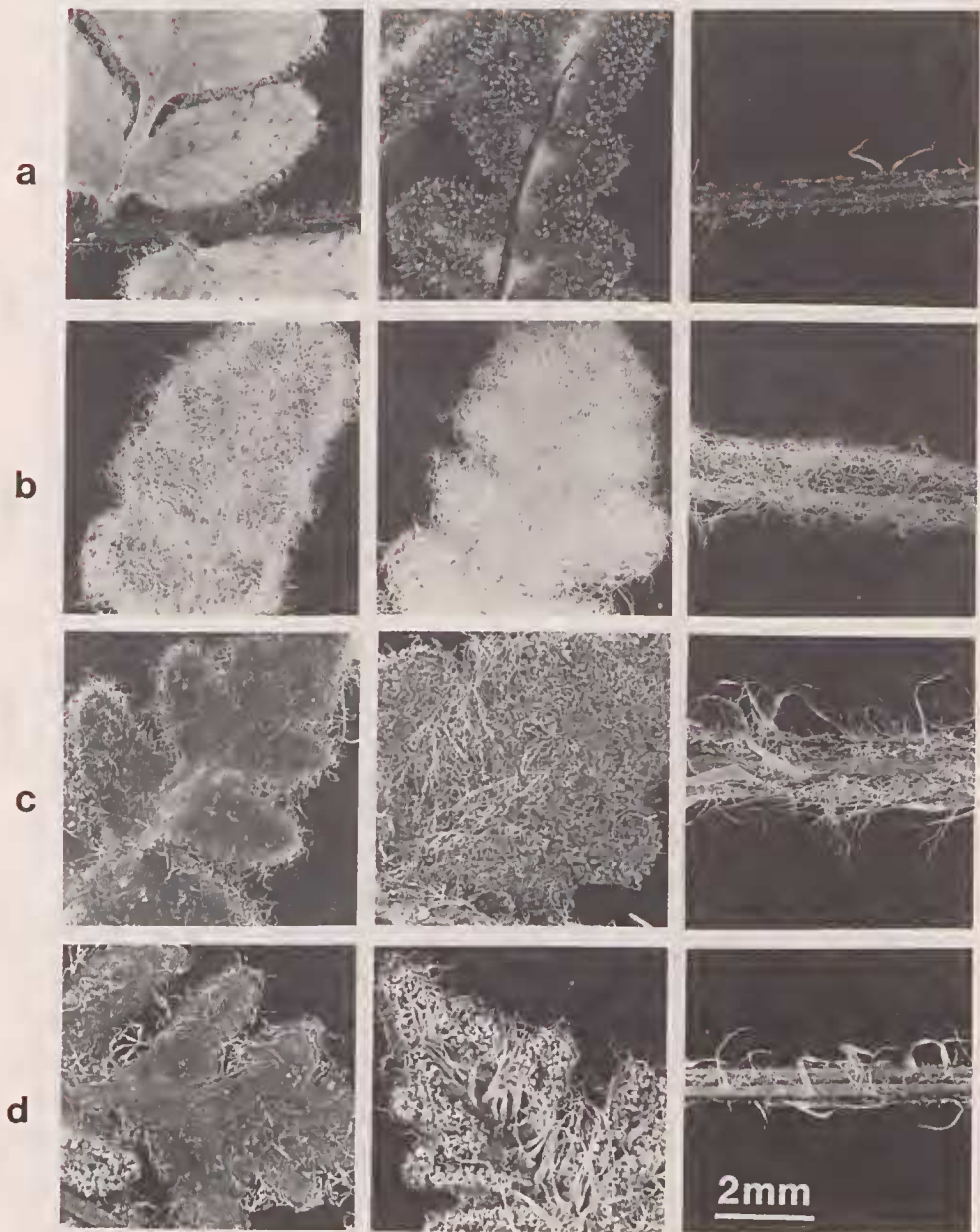


Figure 4. Hair and scale characteristics of *Cheilanthes* species (all from specimens in NSW): upper (adaxial) pinnule surface, lower (abaxial) pinnule surface and stipe (a, c, d) or rhachis (b); all to same scale: a, *C. hirsuta*: A. Tryon 7346 & R. Tryon; b, *C. brownii*: Swinbourne 685; c, *C. lasiophylla*: upper pinnule surface and stipe: Learmouth ACB 7568; lower pinnule surface: Constable, NSW 192214; d, *C. distans*: upper and lower pinnule surfaces: Chinmock 204; stipe: Morrow 42.

Table 1. Salient characters of Australian *Cheilanthes* taxa (glab. = glabrous; mod. = moderately dense; esp. = especially)

Species and spore number	FronD division at base	Stipe	Rhachis and rhachillas	Upper pinnule surface	Lower pinnule surface	Other features
<i>sieberi</i> subsp. <i>sieberi</i> 16 (32)	3-pinnate	glabrous or sparse to mod. hairs & scales	glabrous or sparse to mod hairs & scales	glabrous	glabrous or very sparse hairs	lamina linear-lanceolate or ovate
<i>sieberi</i> subsp. <i>pseudovellea</i> 16	3-pinnate	glabrous or sparse to mod. hairs & scales	mod. to dense long twisted hairs	sparse to mod. long twisted hairs	sparse to dense long twisted hairs	lamina linear-lanceolate or ovate
<i>adiantoides</i> 32	3-pinnate or 2-pinnate	glab. or sparse hairs & scales esp. junctions	sparse hairs & scales densest at junctions	glabrous	glabrous	lamina ovate; infolded fertile pinnules
<i>austrotenuifolia</i> 32	4-pinnatifid or 3-pinnate	glabrous or sparse hairs and scales	sparse to mod. scales & hairs esp. junctions	glabrous	sparse hairs & scales esp. on midribs	lamina deltoid, elliptic, ovate or lanceolate
<i>tenuifolia</i> 32	4-pinnate or 3-pinnate	glabrous or sparse hairs and scales	glabrous or sparse hairs and scales	very sparse short acute hairs	sparse short hairs esp. on midribs	lamina pentagonal, deltoid or ovate
<i>contigua</i> 32	4-pinnate or 3-pinnate	glab. or sparse to dense short hairs; few scales	mod. to dense short hairs; sparse scales	sparse to dense minute or short hairs	sparse to dense hairs esp. on midribs	lamina deltoid, elliptic or ovate
<i>fragillima</i> 32	4-pinnate or 3-pinnate	glabrous	sparse to mod. straight acute hairs	sparse long straight hairs esp. margins	sparse long straight hairs	lamina deltoid or ovate
<i>caudata</i> 32 (16)	3-pinnate or 4-pinnatifid	glabrous or sparse hairs	glabrous or sparse hairs	glabrous or sparse short or minute hairs	glabrous or sparse short or minute hairs	lamina ovate or deltoid; caudate at extremities

Species and spore number	FronD division at base	Stipe	Rhachis and rhachillas	Upper pinnule surface	Lower pinnule surface	Other features
<i>nitida</i> 32	2-pinnate (3-foliolate inner pinnule)	glabrous or sparse hairs	glabrous or sparse hairs	glabrous or minute rigid hairs	glabrous or short hairs on midrib	lamina ovate or oblong; long linear pinnules
<i>praetermissa</i> 32	2-pinnate or 3-pinnatifid	glabrous or sparse hairs and scales	glabrous or sparse hairs and scales	glabrous or sparse short hairs	glab. to sparse hairs esp. on midribs	lamina deltoid; midribs dark for part of length
<i>pumilio</i> 32 (16)	1-pinnate to 3-pinnate	glab. or sparse to mod. hairs; sparse scales	glab. or sparse to mod. hairs; sparse scales	glab. or sparse to dense hairs esp. margins	glab. or sparse to dense hairs, esp. midribs	lamina deltoid or ovate; membranous
<i>prenticei</i> 32	2-pinnate or 3-pinnate	glab. or sparse to dense hairs; sparse scales	mod. to dense short to medium hairs	glab. or sparse to mod. hairs, esp. margins	mod. to very dense hairs	lamina elliptic, ovate or lanceolate; somewhat caudate
<i>hirtuta</i> 16	2-pinnate or 3-pinnate	glabrous or sparse hairs; sparse scales	sparse to mod. hairs; sparse scales	sparse hairs esp. at margins, or rarely glabrous	sparse to dense hairs	lamina elliptic or lanceolate; pinnules obtuse or acute
<i>brownii</i> 16 (32)	2-pinnate or 3-pinnate	sparse to dense long fine hairs; sparse scales	sparse to dense long fine hairs; sparse scales	sparse to very dense long fine hairs	extremely dense long fine hairs	lamina elliptic or lanceolate; pinnules rounded
<i>lasiophylla</i> 16	2-pinnate	mod. to dense branched scales	mod. to dense branched scales	sparse to mod. branched hairs	dense branched sparse scales	lamina elliptic or lanceolate; scales & hairs branched
<i>distans</i> 16	2-pinnatifid or 2-pinnate	mod. to dense scales; sparse hairs	dense scales	sparse to mod. hairs; very sparse scales	sparse to dense scales; very sparse hairs	lamina linear

difficulty in obtaining full, mature sporangia. *C. fragillima* has 32 spores per sporangium and a spore size range of 41–50 μm diam. ($n=5$) (Figure 6e).

C. pumilio. The spore size of 24 μm diam. given by Quirk et al. (1983: 533) is incorrect. Furthermore the present study has shown that *C. pumilio* can have either 32 spores (33–50 μm diam.) (Figure 7d–f) or 16 spores (50–68 μm diam.) (Figure 7g,h) per sporangium and that the type material of *C. pumilio* has 16 spores per sporangium rather than 32 as was originally thought by Quirk et al. (1983).

C. brownii. This study has shown that *C. brownii* can have either 32 spores (34–48 μm diam.) (Figure 8f,g) or 16 spores (47–71 μm diam.) (Figure 8h) per sporangium.

Scatter diagrams

The following characters were examined in specimens of apparently closely related taxa (see Table 1): frond division, hair density and length for the stipe, rhachis, lower pinnule surface and upper pinnule surface.

Four character states were used for each, as follows:

Frond division: 1. pinnate 2. bipinnate 3. tripinnate 4. quadripinnate

Hair density: 1. absent 2. sparse 3. moderately dense 4. dense

Hair length: 1. minute (< 0.2 mm) 2. short (0.2–0.5 mm) 3. medium (0.5–1.0 mm) 4. long (≥ 1.0 mm)

These character states necessarily represent points on a continuum, with intermediate points on the scatter diagrams representing either averages for different parts of the plant, or in the case of frond division, states of bipinnatifid (1.5), tripinnatifid (2.5) and so on.

The scatter diagrams (Figures 9 & 10) summarize the character states for a number of taxa difficult to separate and allow comparisons to be made. The number of specimens examined for each taxon is given in the figure legends. Each dot on the figures represents a single herbarium specimen from a single collection, though the dot may also represent a number of specimens that have identical co-ordinates. In Figures 9 and 10 the values for stipe and rhachis hair density are averages of stipe hair density and rhachis hair density; likewise pinnule hair length and pinnule hair density are averages of the values for upper and lower pinnule surfaces. The conclusions drawn from the scatter diagrams are presented in the 'Notes' sections of the relevant taxa.

Cheilanthes

Cheilanthes Sw.

Swartz, Syn. Fil. 5: 126 (1806)

TYPE: *C. micropteris* Swartz

Neurosoria Mettenius, Bot. Zeitung (Berlin) 27: 437 (1869). HOLOTYPE: *N. pteroides* (R. Br.) Mettenius in Kuhn (*Acrostichum pteroides* R. Br.).

Ground ferns with shortly creeping horizontal scaly rhizomes. *Stipes* slender, $\frac{1}{3}$ to $3\frac{1}{2}$ times the length of the lamina. *Stipe, rhachis and rhachillas* glabrous to densely hairy and/or scaly. *Fertile and sterile fronds* produced, similar or dimorphous, erect or spreading. *Lamina* pinnate to quadripinnate at the base. Larger pinnae to 14-paired,

opposite to subopposite or alternate, petiolulate or sessile, lowermost with basiscopic half equally or more developed than acroscopic. *Pinnules* sessile or with very short petiolules, surfaces glabrous to densely hairy and/or scaly. *Sori* marginal, discrete or continuous, often protected by the inrolled pinnule margin. *Spores* tetrahedral, rounded-tetrahedral or spherical, variously ornamented, 16 or 32 per sporangium.

DISTRIBUTION AND HABITAT: A worldwide genus of at least 180 species with 15 representatives in Australia. Occurs throughout Australia, extending from areas close to the coast to inland regions of more severe aridity than any other fern genus can tolerate. It typically occurs in dry stony areas both in open woodlands and on exposed sites. Several taxa appear to be endemic to Australia: *Cheilanthes adiantoides*, *C. austrotenuifolia*, *C. brownii*, *C. caudata*, *C. fragillima*, *C. lasiophylla*, *C. nitida*, *C. praetermissa*, *C. pumilio*, *C. sieberi* subsp. *pseudovellea*. Three (*C. tenuifolia*, *C. contigua* and *C. hirsuta*) occur also in S.E. Asia, and two (*C. distans* and *C. sieberi* subsp. *sieberi*) in New Zealand and some Pacific islands. *Cheilanthes prenticei* is found in the Cape York area and on Thursday Island in the Torres Strait (Figures 11 & 12).

Species of *Cheilanthes* are often amongst the first green plants to show new growth in some of the rough pastoral country of Australia after drought, sometimes leading to poisoning of domestic stock that are not adapted to this food source.

NOTE: All the descriptions that follow the key, except that for the new species *Cheilanthes adiantoides*, contain only the relevant information that we believe to be necessary for identification of the Australian *Cheilanthes*; full descriptions of these species may be found in Quirk et al. (1983) and in Jones (1988). All types and other specimens referred to in this publication have been seen by one or both of the authors unless otherwise indicated.

[Key to species: see page 528]

Figure 5. (page 520) Spores of *Cheilanthes* species, scale bar = 10 µm (applicable to all species shown). a–d, *C. sieberi* subsp. *sieberi*: a D. Symon 76 (16-spored specimen), b A.F. Davies & D. Errey ACB 20385 (16-spored specimen), c, d G. Chippendale 3643 (32-spored specimen). e, *C. sieberi* subsp. *pseudovellea*: e R. Coveny 567. f, g, *C. adiantoides*: f M.D. Tindale 2754, g R.J. Chinnock 5274 (type).

Figure 6. (page 521) Spores of *Cheilanthes* species, scale bar = 10 µm (applicable to all species shown). a, b, *C. austrotenuifolia*: a R. Helms, NSW 192117, b P.G. Wilson 1870. c, d, *C. tenuifolia*: c R.L. Specht 506, d S. Jacobs 5476 & J. Clarkson. e, *C. fragillima*: C. Dunlop 4445. f, *C. contigua*: S. Jacobs 5390 & J. Clarkson. g–i, *C. caudata*: g D.L. Jones 1478 (DNA) (*C. pinnatifida* type, 32-spored specimen), h D.L. Jones 1549 (32-spored specimen), i A. & R. Tryon 7344 (16-spored specimen).

Figure 7. (page 522) Spores of *Cheilanthes* species, scale bar = 10 µm (applicable to all species shown). a, b, *C. praetermissa*: a M.D. Tindale 10040 & P. Munns, b M. Lazarides 7876. c, *C. nitida*: S. Jacobs 5473 & J. Clarkson. d–h, *C. pumilio*: d Dunlop 5838 (DNA) (*C. dunlopii* type, 32-spored specimen), e Henshall 1951 (DNA) (*C. cavernicola* type, 32-spored specimen), f W.W. Froggatt, NSW 217223 (32-spored specimen), g Banks & Solander, NSW 192292 (fragment of holotype, 16-spored specimen), h C.H. Gittins, NSW 228462 (16-spored specimen).

Figure 8. (page 523) Spores of *Cheilanthes* species, scale bar = 10 µm (applicable to all species shown). a, *C. lasiophylla*: H.J. Eichler, NSW 192190. b, *C. distans*: D.F. Blaxell 522. c, d, *C. prenticei*: c Tate, NSW 218102, d Coppinger, NSW 218097. e, *C. hirsuta*: S.T. Blake 23391. f–h, *C. brownii*: f K.L. Wilson 5225 (32-spored specimen), g, B. Maloney 5 (32-spored specimen), h S. Jacobs 1567 (16-spored specimen).

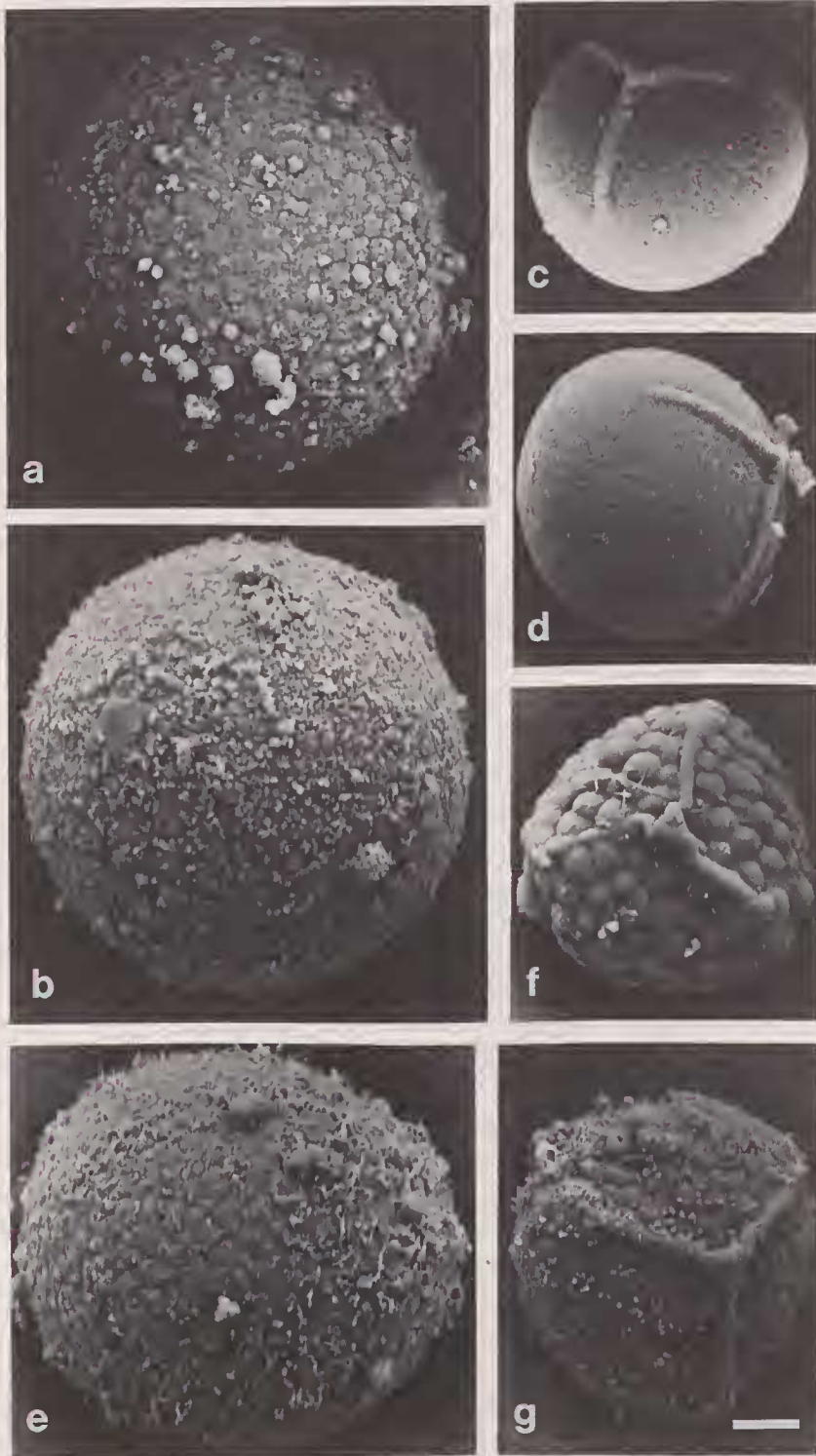


Figure 5.

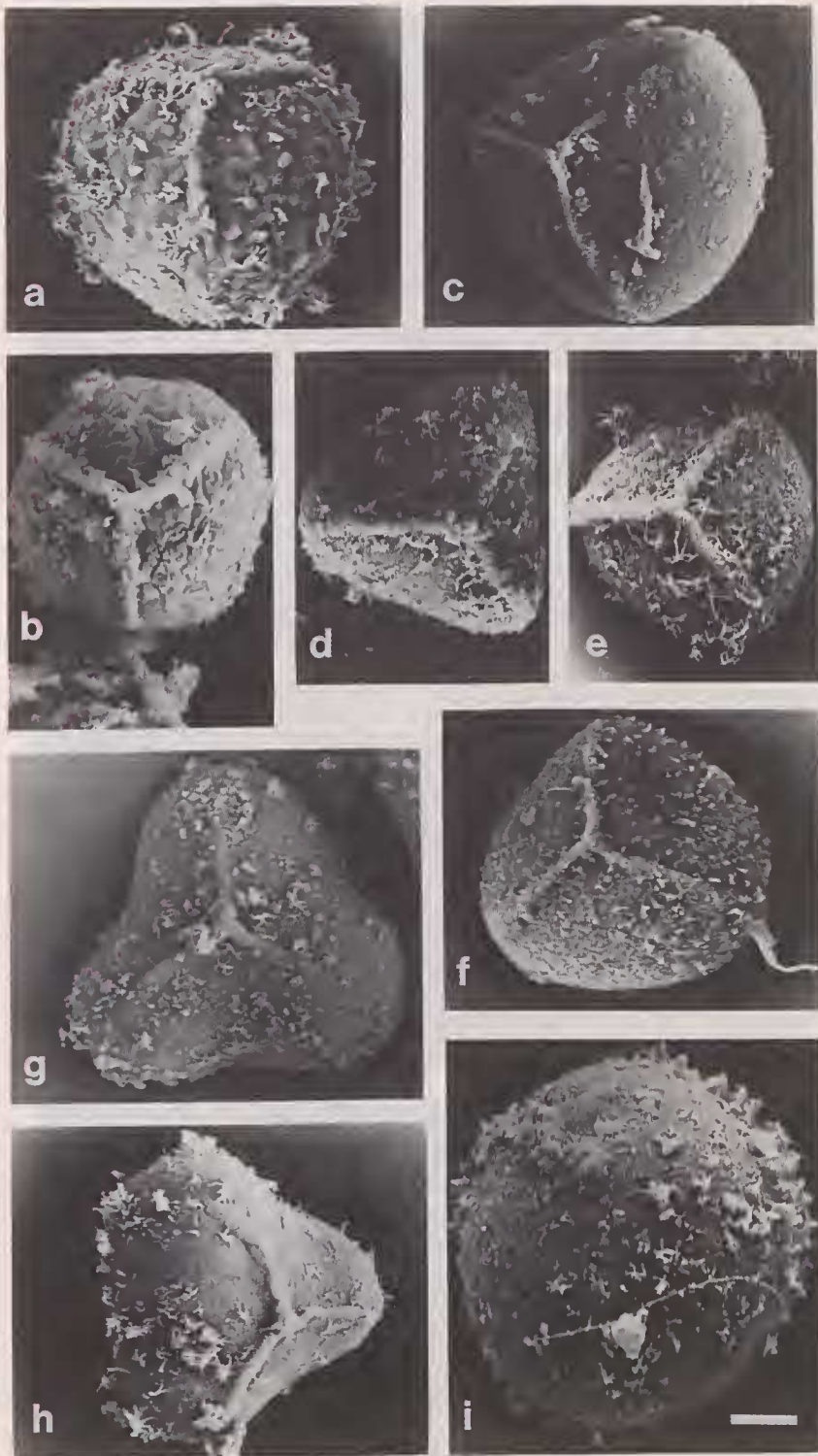


Figure 6.

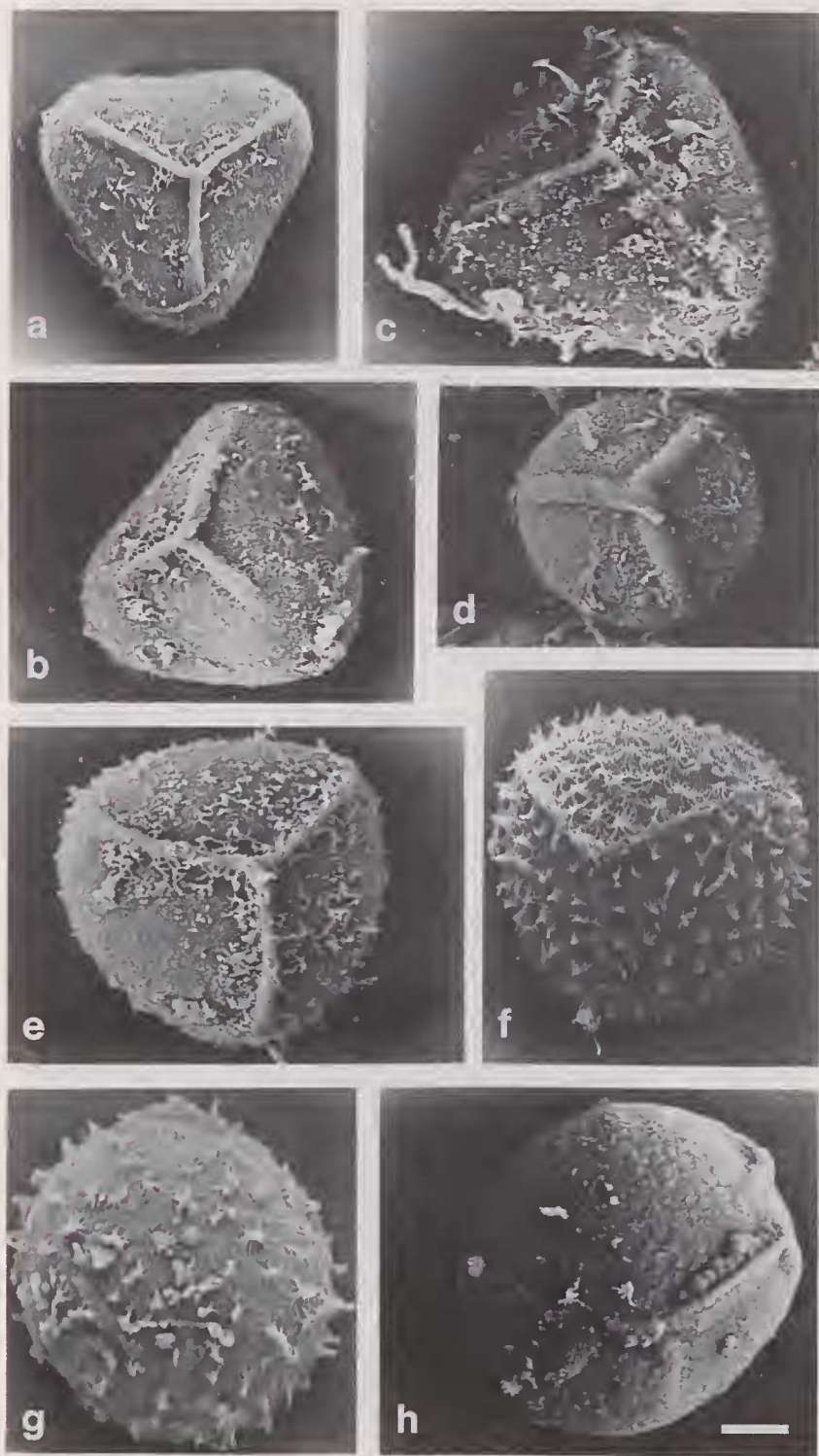


Figure 7.

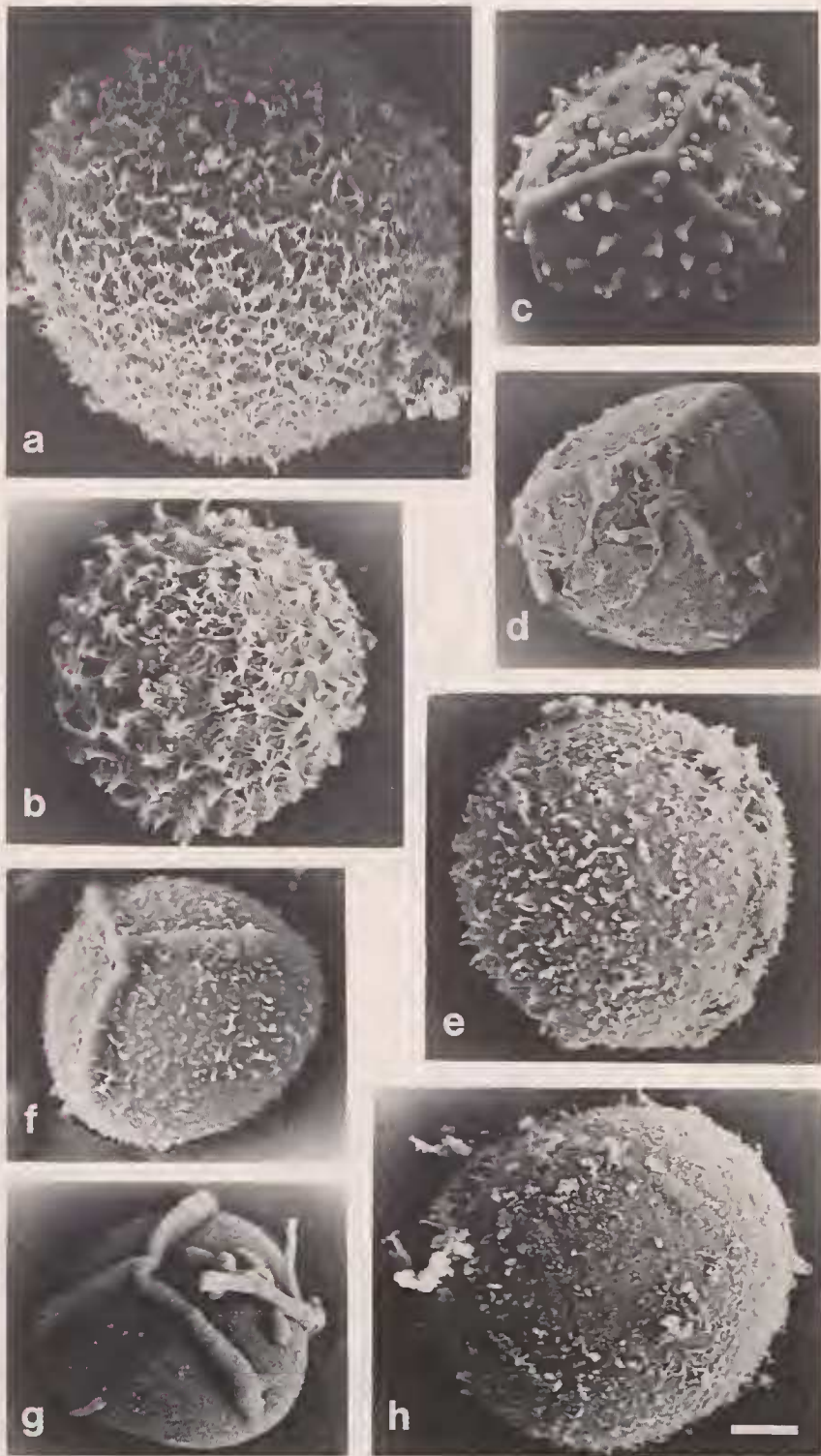


Figure 8.

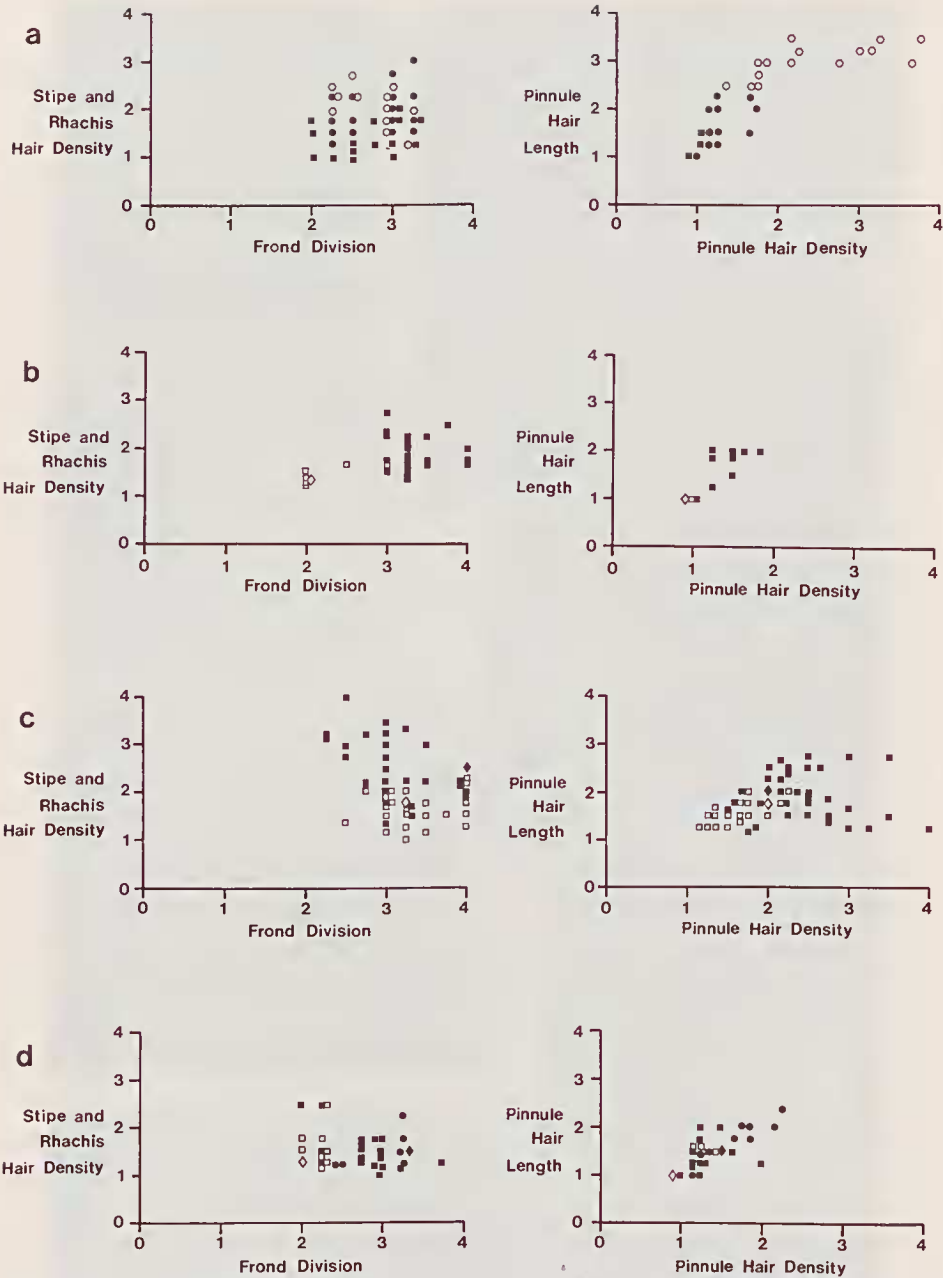


Figure 9. Scatter diagrams. *FronD division* vs *stipe and rhachis hair density* (left) and *pinnule hair density* vs *pinnule hair length* (right); circles represent 16-spored specimens, squares represent 32-spored specimens; diamonds represent type specimens: a, *C. sieberi* subsp. *sieberi*: 16-spored (closed circles; 28 specimens), 32-spored (closed squares; 17 specimens); *C. sieberi* subsp. *pseudovellea* (open circles; 17 specimens); b, *C. adiantoides* (open squares; 15 specimens; open diamond: type); *C. austrotenuifolia* (closed squares; 25 specimens); c, *C. tenuifolia* (open squares; 40 specimens; open diamond: type); *C. configua* (closed squares; 38 specimens; closed diamond: type); d, *C. caudata*: 16-spored (closed circles; 7 specimens), 32-spored (closed squares; 29 specimens; closed diamond: type); *C. nitida* (open squares; 14 specimens; open diamond: type).

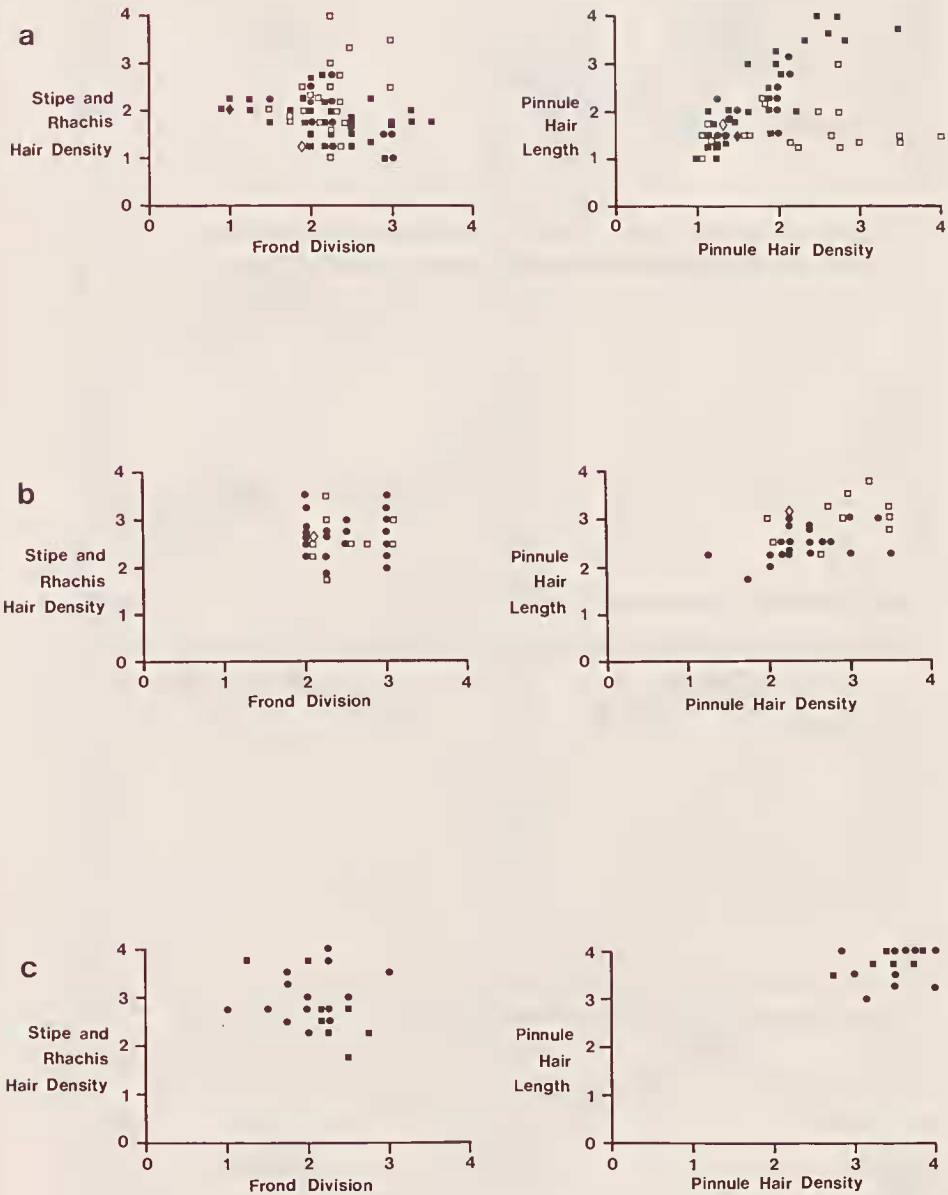


Figure 10. Scatter diagrams. *FronD division* vs *stipe and rhachis hair density* (left) and *pinnule hair density* vs *pinnule hair length* (right); circles represent 16-spored specimens, squares represent 32-spored specimens; diamonds represent type specimens: a, *C. praetermissa* (open squares; 12 specimens; open diamond: type); *C. pumilio*: 16-spored (closed circles; 11 specimens; closed diamond: type), 32-spored (closed squares; 47 specimens); b, *C. prenticei* (open squares; 12 specimens; open diamond: type); *C. hirsuta* (closed circles; 30 specimens); c, *C. brownii*: 16-spored (closed circles; 18 specimens), 32-spored (closed squares; 12 specimens).



Figure 11. Australian distribution of *Cheilanthes* species: a, *C. sieberi* subsp. *sieberi*; b, *C. sieberi* subsp. *pseudovellea*; c, *C. adiantoides*; d, *C. austrotenuifolia*; e, *C. tenuifolia*; f, *C. contigua*; g, *C. fragillima*; h, *C. caudata*.



Figure 12. Australian distribution of *Cheilanthes* species: a, *C. nitida*; b, *C. praetermissa*; c, *C. pumilio*; d, *C. prenticei*; e, *C. hirsuta*; f, *C. brownii*; g, *C. lasiophylla*; h, *C. distans*.

Key to the species

- 1 Lamina linear and usually 1- or 2-pinnate at the base; more scaly than hairy, coarse scales at least on lower pinnule surface 15. *C. distans*
- 1* Lamina linear to deltoid and 1- to 4-pinnate at the base; glabrous, hairy or woolly, rather than scaly, though scales may be present
 - 2 Ultimate pinnules linear and narrow (usually 0.5-2 mm) throughout lamina, at least five times longer than broad; usually glabrous
 - 3 Ultimate pinnules at least ten times longer than broad; entire throughout; lamina 2-pinnate or sometimes with trifoliolate innermost pinnules at the base 8. *C. nitida*
 - 3* Ultimate pinnules less than ten times longer than broad; with caudate tips and incised bases at lamina extremities; lamina 3- or 4-pinnate at the base 7. *C. caudata*
 - 2* Ultimate pinnules not narrow, or if narrow then not linear, or less than five times longer than broad; glabrous, hairy or woolly
 - 4 Lamina woolly with long hairs (usually > 1 mm) especially on lower surface; pinnules lacking marginal fringe of hairs
 - 5 Scales abundant on stipe and rhachis; hairs and bases of scales branched (may need to remove one to see this) 14. *C. lasiophylla*
 - 5* Few scales on stipe and rhachis; hairs and bases of scales not branched
 - 6 Lamina 2- or rarely 3-pinnate at the base; pinnules deltoid and rounded 13. *C. brownii*
 - 6* Lamina 3- or 4-pinnate at the base; pinnules lanceolate to elliptic and obtuse 1. *C. sieberi*
 - 4* Lamina glabrous to densely hairy; with or without marginal fringe of hairs
 - 7 Pinnules membranous; veins conspicuous; glabrous to densely hairy; margin not usually inrolled; 1- to 3- pinnate at the base 10. *C. pumilio*
 - 7* Pinnules usually leathery; veins not usually conspicuous; glabrous or hairy; margin inrolled in some species; lamina 2- to 4-pinnate at the base
 - 8 Lamina deltoid and 2-pinnate or 3-pinnatifid at the base; midribs on abaxial side dark for part of their length 9. *C. praetermissa*
 - 8* Lamina linear to deltoid, but if deltoid then 3- or 4-pinnate at the base; midribs on abaxial side not dark for part of their length

- 9 Upper pinnule surface and margin completely glabrous; lower pinnule surface glabrous or hairy; pinnules at extremities of lamina not caudate
- 10 Lamina linear or ovate; either glabrous or with more hairs than scales at stipe-rhachis-rhachilla junctions 1. *C. sieberi*
- 10* Lamina ovate or deltoid; scales predominant at stipe-rhachis-rhachilla junctions
- 11 Lamina 2- to 3-pinnate at the base; pinnules rhomboid, broadly falcate or flabellate; margin strongly inrolled 2. *C. adiantoides*
- 11* Lamina 3- or 4-pinnate at the base; pinnules ovate; margin inrolled slightly 3. *C. austrotenuifolia*
- 9* Upper pinnule surface and/or margin with minute to long, very sparse to moderately dense hairs; lower surface with sparse to dense hairs; pinnules at extremities of lamina sometimes caudate
- 12 Lamina 3- or 4-pinnate at the base and deltoid; sparse to moderately dense long straight stiff pointed hairs on all surfaces including margin 6. *C. fragillima*
- 12* Lamina 2- to 4-pinnate at the base and linear to deltoid; hairs not as above
- 13 Lamina 3- or 4-pinnate at the base; ovate or deltoid; short hairs (<0.5 mm) on upper pinnule surface; longer hairs on lower pinnule surface
- 14 Pinnules obovate and obtuse, crowded on pinnae; sparse to moderately dense hairs on upper pinnule surface and rhachis; sparse hairs on lower pinnule surface, especially along midrib; marginal hairs sometimes present 5. *C. contigua*
- 14* Pinnules ovate and acute, well spaced on pinnae; very sparse or sparse hairs on pinnule surfaces and rhachis; no marginal hairs 4. *C. tenuifolia*
- 13* Lamina 2- or rarely 3-pinnate at the base and linear or ovate; surface and/or margin of upper pinnules with short to medium length hairs (usually 0.5–1 mm); longer hairs on lower pinnule surface
- 15 Pinnae at base of lamina markedly basiscopically developed; moderately dense to very dense hairs on lower pinnule surface; conspicuous marginal fringe 11. *C. prenticei*
- 15* Pinnae at base of lamina not markedly basiscopically developed; sparse to moderately dense hairs on lower pinnule surface and margin 12. *C. hirsuta*

1. *Cheilanthes sieberi* Kunze in Lehmann, Pl. Preiss. 2: 112 (1847)

LECTOTYPE (Quirk et al. 1983: 517, Figure 10 ii, iv): WESTERN AUSTRALIA: Swan River, *Preiss 1304* (BM). ISOLECTOTYPE: P.

Cheilanthes tenuifolia subsp. *sieberi* (Kunze) Domin, Biblioth. Bot. 85: 140 (1915). LECTOTYPE: as for *C. sieberi*.

Cheilanthes tenuifolia subsp. *tenuifolia* f. *gracilior* Domin, Biblioth. Bot. 85: 138 (1915). LECTOTYPE (here chosen): SOUTH AUSTRALIA: Mt Lyndhurst, *Max Koch*, Aug 1928 (PERTH).

[*Cheilanthes sieberi* Kunze, Ind. Sem. Hort. Lips.: [1] (1839), nom. nud.]

Fronds to 35 cm long and 3.5 cm wide. *Stipe* dark brown or red-brown, glabrous or with sparse to moderately dense hairs and scales. *Rhachis* colour as for *stipe*, glabrous or with sparse to moderately dense hairs (to 10 cells long) and scales, hairs often twisted and glandular, densest at *stipe-rhachis-rhachilla* junctions. *Lamina* linear-lanceolate or ovate, tripinnate at the base, bipinnate for most of its length. *Larger pinnae* deltoid-ovate. *Pinnules* obtuse, lanceolate, ovate or elliptic, margins deeply incised and inrolled, upper and lower surfaces glabrous or with twisted hairs. *Spores* spherical, ornamented with varying amounts of globular, branched or reticulate deposits, verrucate beneath ornamentation, either black, ridged, 49–73 µm diam., 16 per sporangium (Figure 5a,b,e), or brown, trilete, 36–52 µm diam., 32 per sporangium (Figure 5c,d).

DISTRIBUTION AND HABITAT: Occurs throughout Australia, in all States and Territories but apparently absent from the extreme north; also recorded in New Zealand and New Caledonia. Found in both arid and non-arid areas. Recognised as poisoning stock especially at regrowth after drought. There are two subspecies.

Unlike Green (1988) and Quirk et al. (1983), we do not believe *Pteris humilis* and *Cheilanthes sieberi* to be the same species; the hair and spore characteristics of Forster's type material of *P. humilis* are typical of *C. tenuifolia* (q.v.) and not *C. sieberi*.

- 1 Upper pinnule surface glabrous; lower pinnule surface glabrous or almost so a. subsp. *sieberi*
- 1* Upper and lower pinnule surfaces with an indumentum of twisted hairs b. subsp. *pseudovellea*

a. *Cheilanthes sieberi* subsp. *sieberi*

ILLUSTRATIONS: Quirk and Chambers (1978: Figures 6a–f [as *C. sieberi*]); Quirk et al. (1983: Figures 10 [types], 11, 36); Andrews (1990: Figure 34.5A).

Rhachis and *rhachillas* glabrous or with sparse to moderately dense hairs and scales. *Pinnules* with glabrous upper surface, lower surface glabrous or with very sparse hairs (Figures 1a; 13f–h). *Spores* large or small, 16 or 32 per sporangium respectively (Figure 5a–d). $2n = 84$ (Quirk et al. 1983: 519).

DISTRIBUTION AND HABITAT: Occurs throughout Australia except for coastal areas of northern Australia (between the Kimberley region of Western Australia and the Cairns region of Queensland) and southern Australia (Great Australian Bight between Cape Arid National Park, Western Australia, and Ceduna, South Australia). Occurs on Lord Howe Island (Figure 11a). Found in arid and non-arid areas, growing in exposed rocky habitats in rock crevices or in the shelter of rocks and sometimes in open woodlands. Also occurs in New Zealand and New Caledonia.

NOTES: Some specimens from central Australia have very sparse scales at the stipe-rhachis-rhachilla junctions; these specimens are easily distinguished from *C. austrotenuifolia* by their large black verrucate spores (Figure 5; Quirk et al. 1983: Figure 36) and so far as we are aware *C. austrotenuifolia* does not occur in this region. The *C. sieberi* subsp. *sieberi* specimens that have small brown trilete spores (32 per sporangium) (Figure 5c,d) rather than the more usual large black spores (16 per sporangium) (Figure 5a,b) are not confined to any particular part of the geographic distribution of the subspecies (Figure 11a). Most 32-spored specimens of *C. sieberi* subsp. *sieberi* fit into the range of the 16-spored specimens on the scatter diagrams (Figure 9a), further supporting the interpretation that they belong to the same taxon. Although Quirk et al. (1983: 519) recognised that there were two different spore size ranges for this taxon, they did not state explicitly that each was associated with a different spore number.

SELECTED SPECIMENS: WESTERN AUSTRALIA: near Roe Dam, 30 km N of Narembeen, R.J. Chinnock 4118, Sep 1977 (NSW, AD). NORTHERN TERRITORY: Todd River, 9 km N of Alice Springs, G. Chippendale, Nov 1954 (DNA, NSW, PERTH); George Gill Range, Kings Canyon, A.C. Beauglehole 20266, Oct 1966 (NSW); George Gill Range, Kings Canyon, A.F. Davies & D. Errey ACB 20385, Oct 1966 (NSW); Reedy Creek, George Gill Range, G. Chippendale 3643, Aug 1957 (NSW); Mt Olga, D. Symon 76, June 1953 (NSW). SOUTH AUSTRALIA: Gammon Ranges, Arcoona Bluff Ra. N of Arcoona Pound, H.J. Eichler 12610, Sep 1956 (AD, NSW). QUEENSLAND: Walshs Pyramid, S.T. Blake 21757, May 1962 (BRI, NSW). NEW SOUTH WALES: Grove Creek, Abercrombie area, E.F. Constable, Mar 1955 (NSW); Narrabri, J.L. Boorman, June 1907 (NSW). VICTORIA: Deddick River, F. Robbins, c. 1937 (NSW); 'Malinns', 52 km N of Orbost on the Bonang Highway, East Gippsland, K.R. Theile 859, Jan 1985 (MELU). TASMANIA: near Antill Ponds, M. Hood 7, July 1951 (HO).

b. *Cheilanthes sieberi* subsp. *pseudovellea* H. Quirk & T.C. Chambers, Austral. J. Bot. 31: 522 (1983).

HOLOTYPE (Quirk et al. 1983: Figure 13): QUEENSLAND: 20 km N of Mt Isa Waterhole, T. Farrell, Feb 1977 (MEL 829830).

SYNONYMY: *Cheilanthes pseudovellea* (H. Quirk & T.C. Chambers) D.L. Jones, *Austrobaileya* 2: 469–480 (1988). HOLOTYPE: as for *C. sieberi* subsp. *pseudovellea*.

ILLUSTRATIONS: Quirk et al. (1983: Figures 12, 13 [holotype], 37 [spore of holotype]); Andrews (1990: Figure 34.5B, C).

Rhachis and *rhachillas* with moderately dense to dense twisted hairs. *Pinnules* with sparse to dense twisted hairs on both surfaces, often denser on lower surface (Figures 1b; 13i,j). *Spores* large, 16 per sporangium (Figure 5e). $2n = 82 \pm 3$ (Quirk et al. 1983: 522).

DISTRIBUTION AND HABITAT: Occurs in central Australia, from eastern Western Australia to South Australia, central New South Wales and Queensland (Figure 11b). Found in soil pockets in rocky areas of arid mountain ranges.

NOTES: *Cheilanthes sieberi* subsp. *pseudovellea* has a limited distribution, in central Australia, within the range of subsp. *sieberi*, and there is evidence that the two sometimes grow together. *Cheilanthes sieberi* subsp. *pseudovellea* differs from subsp. *sieberi* in its hair cover. Although the two subspecies are arbitrarily separated on the basis of presence or absence of hairs on the upper pinnule surface, a few specimens grade into one another. Somewhat intermediate specimens include DNA 49288, DNA 42375 and NSW 192535 (here assigned to subsp. *pseudovellea*) and NSW 192373 and NSW 192374 (here assigned to subsp. *sieberi*). These intermediate specimens may be hybrids between the two subspecies, although we have no definite evidence to confirm this. Given that the two have similar morphology and spore characteristics, we

do not accept Jones' (1988) raising of subsp. *pseudovellea* to specific rank. Our interpretation of the scatter diagrams support this view (Figure 9a): the two subspecies are very similar in morphological characters (for example, frond division and stipe and rhachis hair density) other than pinnule hair characters; the areas on the scatter diagrams for pinnule hair characters form a continuum within the species. While the two subspecies are readily recognised on hair characters (other than the few intermediates reported here for the first time), an examination of Figure 1a,b and Figures 10–13 in Quirk et al. (1983) will indicate how similar the two subspecies are other than in pubescence.

Cheilanthes sieberi subsp. *pseudovellea* was named because of its cover of hairs, which led previous workers to mistakenly identify it as *C. vellea*, now known as *C. brownii*. In general *C. sieberi* subsp. *pseudovellea* is easily distinguished from *C. brownii* by frond shape and by the nature (hairs twisted and often glandular in subsp. *pseudovellea*) and density of hair cover. Some specimens of *C. brownii* (for example, DNA 82176, DNA 81828, DNA 58046), however, have proved difficult to separate because of similarity in spore size and ornamentation to spores of *C. sieberi* subsp. *pseudovellea* (Quirk et al. 1983: Figure 37). Such specimens may be hybrids (although we have no evidence to confirm this) as the two species are usually quite distinct.

Unlike *C. sieberi* subsp. *sieberi* and *C. brownii*, no specimens of *C. sieberi* subsp. *pseudovellea* have been found with sporangia containing 32 trilete spores. In this study we have only found large spores (53–73 μm diam.) (Figure 5e) and the diameter of 32 μm given by Quirk et al. (1983: 522) seems incorrect although the size of the spore in Figure 37 of their paper is accurate.

SELECTED SPECIMENS: WESTERN AUSTRALIA: Winjana Gorge, Lennard River, Napier Range, Kimberleys, A.C. Beaglehole 11220, Aug 1965 (NSW). NORTHERN TERRITORY: Macdonnell Ranges 36 km NW of Alice Springs, D.J. Nelson 1745, Aug 1968 (DNA, NSW); Heavitree Gap, R. Coveny 544, Aug 1968 (NSW); Aileron Rocks, Central Australia, (grown in glasshouse), D. Gaff, Aug 1971 (MEL); Valley of the Winds, Mt Olga, SW of Alice Springs, R. Coveny 567, Aug 1968 (NSW). SOUTH AUSTRALIA: North-western end of Musgrave Ranges c. 25 km WSW of Amata, W.R. Barker 3498, Sep 1978 (AD). QUEENSLAND: 3.5 km W of Duchess, C.H. Gittins, May 1963 (NSW). NEW SOUTH WALES: Mount Forster, 50 miles [90 km] NW of Warren, E.F. Constable, May 1952 (NSW).

2. *Cheilanthes adiantoides* T.C. Chambers & P.A. Farrant sp. nov.

Fronde 5–15(–25) cm longae ovatae vel oblongo-ovatae ad 9 cm latae tripinnatae per 1–2 inferiora paria pinnarum gradatim bipinnatae sursum pinnatae. Pinnulae glabrae. Pinnulae fertiles rhombicae vel lanceolatae vel ovatae; margines crenati introflexique. Pinnulae steriles flabellatae vel deltatae. Sporae 32 per sporangium.

HOLOTYPE: WESTERN AUSTRALIA: 29.4 km SE of Mullewa, 28°42'S, 115°40'E, R.J. Chinnock 5274, 21 Oct 1981 (NSW). ISOTYPE: AD.

Rhizome horizontal, at least to 4 cm long and c. 2.5 mm diam., putting forth many densely tufted fronds and thickly clothed with scales that are lanceolate, entire, c. 2 mm long, 0.1 mm broad, light brown, sometimes with dark brown centres. *Fronde* dimorphous; fertile fronds 5–15(–25) cm long, erect, to 9 cm wide; sterile fronds shorter, to 10 cm long, spreading, to 5 cm wide. *Stipe* red-brown to brown, 0.5–1.00 mm wide and $\frac{1}{3}$ –2 times the length of the lamina, shiny, terete, grooved, glabrous or with very sparse 10–12-celled hairs and very sparse slender scales c. 2 mm long that are densest at the junction with the rhachis. *Rhachis* colour as for stipe, with sparse hairs (to 10 cells long) and long scales that are densest at the junctions with rhachillas. *Lamina* ovate or oblong-ovate, tripinnate or bipinnate for lower 1–2 pinnae, bipinnate to pinnate above. *Larger pinnae* 3–6-pairs, opposite, subopposite or alternate, elliptic,

ovate or oblong-ovate, petiolulate, lowermost 1.5–4.5 cm long, basiscopic halves slightly more developed than acroscopic. *Pinnules* sessile or shortly petiolate, 1–9 mm long, 1–6 mm wide, obtuse to somewhat acute, flabellate or deltoid on sterile fronds, rhomboid, ovate or lanceolate on fertile fronds if flat, or blunt and broadly falcate if folded in half laterally, margins of fertile pinnules crenate and conspicuously inrolled, often almost meeting mid-pinnule, margins of sterile pinnules entire or lobed, upper and lower surfaces glabrous, nervillae conspicuous especially at pinnule margins, usually forked. *Sori* continuous along the pinnule margin, black at maturity, entirely covered by the inrolled pinnule margin (Figures 1c; 15f–h). *Sporangia* very short-stalked, spherical, c. 0.1–0.2 mm in diameter. *Spores* black-brown, rounded-tetrahedral, varying amounts of globular and cristate ornamentation, coarsely verrucate and trilete beneath ornamentation, 41–54 μm diam., 32 per sporangium (Figure 5f,g).

DISTRIBUTION AND HABITAT: Occurs in south-western Western Australia (Figure 11c). Found around granite outcrops, on damp banks and around the bases of trees in soils over granite. A winter grower, which dries off by early spring and is possibly overlooked by collectors.

NOTES: This new species was discovered by Dr R.J. Chinnock after the publication of Quirk et al. (1983). *Cheilanthes adiantoides* is so named because the flabellate shape of its sterile pinnules is reminiscent of the genus *Adiantum*: indeed, sterile specimens could be easily confused with this genus. The species is most easily confused with *C. austrotenuifolia*, which also has scales at stipe–rhachis–rhachilla junctions. It may also be confused with *C. sieberi* subsp. *sieberi* (both have verrucate spores, see Figures 5a,f,g). *Cheilanthes adiantoides* is nonetheless a distinct species, easily recognised by its very inrolled pinnule margins (and hence rhomboid-shaped pinnules), conspicuous nervillae and distinctive spore morphology. The scatter diagrams (Figure 9b) show that *C. adiantoides* is distinguishable from *C. austrotenuifolia* also on the basis of frond division and pinnule hair characters; in frond division *C. adiantoides* appears more similar to *C. sieberi* subsp. *sieberi* (Figure 9a,b).

SELECTED SPECIMENS: WESTERN AUSTRALIA: c. 40 miles [64 km] W of Bullfinch, M.E. Phillips, Sep 1962 (NSW); 12.6 km S of Merredin on the Bruce Rock road, R.J. Chinnock P1095, Sep 1976 (NSW, AD); Howatharra Range, 7.5 km N of Nanson, M.D. Tindale 2709, 2754, Aug 1973 (NSW); Swan River 2–4 miles [3–6 km] above Northam, H. Salasoo 337, Oct 1949 (NSW).

3. *Cheilanthes austrotenuifolia* H. Quirk & T.C. Chambers, Austral. J. Bot. 31: 510 (1983).

HOLOTYPE (Quirk et al. 1983: Figures 4 & 5): VICTORIA: You Yangs Forest Park, H. Quirk 79, Apr 1975 (MEL 515001).

ILLUSTRATIONS: Quirk & Chambers (1978: Figures 3a, 4a–d); Quirk et al. (1983: Figures 4, 5, 33 [all illustrating holotype]).

Fronds to 55 cm long and 20 cm wide. *Stipe* red-brown to brown, glabrous or with sparse slender hairs (to 10 cells long) and sparse slender scales densest at the junction with the rhachis. *Rhachis* colour as for stipe, sparse hairs (to 10 cells long) and sparse to moderately dense scales, densest at the junctions with rhachillas. *Lamina* deltoid, elliptic, ovate or lanceolate, quadripinnatifid or tripinnate at base, tripinnate or bipinnate for most of its length. *Larger pinnae* deltoid-ovate. *Pinnules* obtuse or somewhat acute, elliptic or ovate, margins crenate and inrolled, upper surface glabrous, lower surface glabrous or with sparse scales and hairs densest along midrib (Figures 1d, 13a–e). *Spores* spherical, with cristate ornamentation, granulose and trilete beneath ornamentation, 33–50 μm diam., 32 per sporangium (Figure 6a,b). $2n = 54 \pm 2$, 58 ± 3 , 59 ± 1 , 55 ± 5 (Quirk et al. 1983: 510).



Figure 13. a-e, *C. austrotenuifolia*: a habit, scale bar = 4 cm; b early season frond, scale bar = 4 cm; c fertile pinna, upper (adaxial) surface, scale bar = 1 cm; d fertile pinnule, lower (abaxial) surface, scale bar = 1 mm; e rhizome scale, scale bar = 1 mm (a,c,d,e: Thiele 858, MELU; b: Beaglehole 66203). f-h, *C. sieberi* subsp. *sieberi*: f fertile frond, scale bar = 4 cm; g fertile pinna, upper (adaxial) surface, scale bar = 1 cm; h fertile pinnule, lower (abaxial) surface, scale bar = 0.5 mm (Thiele 859, MELU). i,j, *C. sieberi* subsp. *pseudovellea*: i fertile pinna, upper (adaxial) surface, scale bar = 5 mm; j hairs from pinna, scale bar = 0.5 mm (Gaff, MEL 516330).

DISTRIBUTION AND HABITAT: Occurs in southern Australia: Tasmania, Victoria, south-eastern New South Wales, southern South Australia and south-western Western Australia (Figure 11d). Found in areas of moderate but irregular rainfall, in rocky ground in open forest areas or on exposed sparsely wooded rocky slopes. Aerial portions of plants usually die off in the hot summer months and regrow in autumn.

NOTES: *Cheilanthes austrotenuifolia* was so named because of its resemblance to the northern *C. tenuifolia*. The two species have disjunct geographical distributions. They were separated by Quirk et al. (1983) largely on the basis of the very different spore morphologies (Quirk et al. 1983: Figures 32, 33), though other morphological differences are now shown to be of equal importance. *Cheilanthes austrotenuifolia* lacks the short hairs on the upper pinnule surface characteristic of *C. tenuifolia* and has scales at some or all of the stipe-rhachis-rhachilla junctions. This last character distinguishes *C. austrotenuifolia* from *C. sieberi* subsp. *sieberi* in areas where their distributions overlap; these two are morphologically more similar than *C. austrotenuifolia* and *C. tenuifolia*. Occasionally plants of *C. sieberi* subsp. *sieberi* from central Australia have some scales at the junctions, but these specimens are easily identified as *C. sieberi* subsp. *sieberi* by their large black verrucate spores (Figure 5a; Quirk et al. 1983: Figure 36), and *C. austrotenuifolia* does not occur in this area.

The name *Cheilanthes preissiana* Kunze in Lehm., Pl. Preiss. 2: 112 (1846), although cited by Christensen (1906) as a synonym of *C. sieberi* Kunze, may refer to *C. austrotenuifolia*. We have been unable to locate the type specimen [Preiss 1308: York (Swan River, Western Australia), ix. 1839] despite contacting all the herbaria that are known to house Preiss, Lehmann and Kunze material. The type may have been destroyed at Leipzig. We have examined Herbarium Henschelianum material in WRSL (no number or other collecting details) labelled, we believe by Kunze, as *C. preissiana* and photos of material in HBG (n.31, cult. Botanic Gardens Leipzig 1839), similarly determined as *C. preissiana*. The WRSL material is *C. austrotenuifolia*. The HBG material is a mixed collection of *C. austrotenuifolia* and *C. sieberi* subsp. *sieberi*. These specimens could perhaps be considered as potential neotype material; however, the mixture of species on one of the sheets is confusing and, without the necessary Preiss collecting number, we are taking the conservative view and maintaining *austrotenuifolia* as the name of the species. We have also examined Preiss 1305 specimens (variously labelled) from BM, G and B, all of which have the characters of *C. austrotenuifolia*.

SELECTED SPECIMENS: WESTERN AUSTRALIA: Devils Slide, Porongurup Range, B.G. Briggs 543 (NSW); Kelmescott, R. Helms, Sep 1898 (NSW). SOUTH AUSTRALIA: Northern Eyre Peninsula, Cunyarie Hills c. 20 km N of Kimba, P.G. Wilson 1870, Sep 1960 (NSW, AD). NEW SOUTH WALES: Green Cape, lighthouse road, E.F. Constable, Oct 1954 (NSW). VICTORIA: Beechworth, A. Meebold 21686, Nov 1936 (NSW); 44 km N of Orbost on the Bonang Highway, East Gippsland, K.R. Thiele 858, Jan 1985 (MELU); Mitre Rock, 10 km W of Natimuk P.O., A.C. Beauglehole 66203, Nov 1979 (MEL). TASMANIA: North Bruny Island, F.A. Rodway, Jan 1901 (NSW).

4. *Cheilanthes tenuifolia* (Burman f.) Swartz, Syn. Fil.: 129, 332 (1806).

BASIONYM: *Trichomanes tenuifolia* Burman f., Fl. Indica: 237 (1768).

HOLOTYPE: CEYLON: Planta Zeylanica collection, Burman (G 1416, 2 sheets).

SYNONYMY: *Cheilanthes tenuifolia* subsp. *tenuifolia*: Domin, Biblioth. Bot. 85: 137 (1915).

Pteris humilis Forster f., Prodr. Fl. Insul. Austral.: 79 (1786). *Cheilanthes humilis* (Forst. f.) P.S. Green, Kew Bull. 43: 653 (1988). LECTOTYPE (Green 1988): [collecting locality and date not indicated in Forster (1786) or on specimens] G. Forster 261 (GOET). ISOLECTOTYPE: BM.

Cheilanthes sciadioides Domin, Biblioth. Bot. 85: 135 (1915). HOLOTYPE: QUEENSLAND: Picnic Creek, Russel [Russell] R., K. Domin 295, 1910 (PR).

Cheilanthes tenuifolia subsp. *queenslandica* Domin, Biblioth. Bot. 85: 140 (1915). HOLOTYPE: QUEENSLAND: Cape False [False Cape] near Yarraba [Yarrabah], K. Domin 307, 1910 (PR).

Cheilanthes tenuifolia subsp. *shirleyana* Domin, Biblioth. Bot. 85: 145 (1915). *Cheilanthes shirleyana* (Domin) H. Quirk & T.C. Chambers, Austral. J. Bot. 31: 510–513 (1983). HOLOTYPE: QUEENSLAND: Chilligaoe [Chillagoe], K. Domin 306, 1910 (PR).

ILLUSTRATIONS: Quirk & Chambers (1978: Figures 3b, 5c–f); Quirk et al. (1983: Figures 1–3, 32; Figures 6, 7, 34 [as *C. shirleyana*]); Andrews (1990: Figure 34.3A–C [A and B as *C. tenuifolia* subsp. *tenuifolia*, C as *C. tenuifolia* subsp. *shirleyana*]).

*Fronde*s to 63 cm long and 17 cm wide. *Stipe* dark red-brown, glabrous or with sparse hairs (2–6 cells long) and very sparse slender scales. *Rhachis* colour as for *stipe*, with sparse hairs (2–13 cells long) and very sparse slender scales. *Lamina* pentagonal, deltoid or ovate, quadripinnate or tripinnate at base, tripinnate for most of its length. *Larger pinnae* deltoid-ovate. *Pinnules* obtuse or acute, lanceolate or ovate, margins entire or lobed, final pinnules sometimes slightly caudate, upper and lower surfaces with very sparse short acute hairs (2–3 cells long) or occasionally almost glabrous (Figures 2a; 14c–e). *Spores* tetrahedral or rounded-tetrahedral, with varying amounts of reticulate-echinate ornamentation, granulose and trilete beneath ornamentation, 38–53 μ m diam., 32 per sporangium (Figure 6c,d). $n = 56$ (specimen from Ceylon, Manton & Sledge 1954).

DISTRIBUTION AND HABITAT: Occurs in coastal regions of Queensland and Northern Territory (Figure 11e). Found on grassy or rocky ground in open forest areas up to 900 m altitude. Also occurs in Nepal, India, Sri Lanka, South-East Asia and the Pacific islands.

NOTES: The earliest name given to the species is *Dryopteris campestris* by Rumphius (1750: 77, t. 34, f. 2), but as this name is pre-Linnaean, it is not included in the species' synonymy. Burman later named the species *Trichomanes tenuifolia*, which was taken by Swartz (1806) as the basionym of *Cheilanthes tenuifolia*.

Domin (1915: 136–146) divided *C. tenuifolia* into a number of new subspecies; his specimens were examined in this study. Domin's specimens of his subspecies *queenslandica* (Domin 307) and *shirleyana* (Domin 306) were found to match Figure 27a and 27b respectively in Domin (1915). *Cheilanthes shirleyana* is here included under *C. tenuifolia*. Although Domin's type and the BRI specimen cited by Quirk et al. (1983: Figures 6 and 7), both examined in this study, are almost glabrous and are broader than most *C. tenuifolia* plants, the spores (Quirk et al. 1983: Figure 34) are not as distinct as believed by Quirk et al. (1983), who examined a narrower range of material. We therefore do not believe that these two specimens are sufficiently distinctive to warrant their recognition as a different taxon.

Both *Cheilanthes tenuifolia* and *C. contigua* have sparse short acute hairs on the upper pinnule surface, but the hairs on the rhachises, rhachillas and midribs of the lower pinnule surface of *C. tenuifolia* (Figure 2a; Quirk et al. 1983: Figures 2 and 3) are sparse whereas those of *C. contigua* are moderately dense (Figure 2b; Quirk et al. 1983: Figure 9). Some specimens are difficult to place as they have some characteristics of both *C. tenuifolia* and *C. contigua*. These specimens may well be hybrids, although we have no evidence (such as aborted spores) to confirm this. As well as some individual specimens being difficult to place, others occur in collections containing material of both species, and this further supports the likelihood of hybrid-

sation between the two species. Apart from the specimens that appear to be 'intermediate,' i.e. that fall into an overlapping area on the scatter diagrams (Figure 9c), most specimens fall into two non-overlapping areas, *C. tenuifolia* specimens in one and *C. contigua* in the other. The two species are usually quite distinctive, not only with respect to the hair characters shown on the scatter diagrams, but also in a large number of other characters. The two species can usually be separated on pinnule shape, the pinnules of *C. tenuifolia* tending to be ovate and acute and those of *C. contigua* obovate and obtuse. The pinnae of *C. tenuifolia* are not usually as well separated along the rhachis nor are the pinnules as crowded as they usually are in *C. contigua* (see Figures 1 and 8 in Quirk et al. 1983).

Rarely specimens of *Cheilanthes tenuifolia* have somewhat caudate pinnule tips (see Figure 7 in Quirk et al. 1983 [as *C. shirleyana*]), but these are not as strikingly caudate as *C. caudata* (see Figure 29 in Quirk et al. 1983), nor are the pinnules glabrous.

SELECTED SPECIMENS: NORTHERN TERRITORY: Giddy River Crossing, *P.K. Latz 2902*, June 1972 (DNA, NSW); Alligator Yards c. 20 km SW of Bauhinia Downs Station, *G.J. Leach 570*, May 1985 (DNA); Walker Creek, Channel Point Road, *D.L. Jones 1756*, Dec 1984 (BRI, CANB, DNA, MEL, NSW); South Bay, Bickerton Island, Gulf of Carpentaria, *R.L. Specht 506*, June 1948 (NSW). QUEENSLAND: 6 miles [10 km] S of Caboolture, *S.T. Blake 21717*, May 1962 (BRI, NSW); Mt Lewis, *S.B. Andrews 281 & G. Stocker*, May 1975 (BRI); Yarrabah, Mission Bay, *P.R. Messmer*, July 1952 (NSW); Herberton, *R.F. Waller*, 1908 (NSW); Garraway Creek, Iron Range road, *S. Jacobs 5476 & J. Clarkson*, Aug 1987 (NSW).

5. *Cheilanthes contigua* Baker, Syn. Fil.: 476 (1874).

HOLOTYPE (Quirk et al. 1983: Figure 8): NORTHERN TERRITORY: Port Darwin, *R. Schomburgk 35*, Oct 1869 (K).

SYNONYMY: *Cheilanthes tenuifolia* subsp. *contigua* (Baker) Domin, *Biblioth. Bot.* 85: 146 (1915). HOLOTYPE: as for *C. contigua*.

Cheilanthes rotunda Bonaparte, *Notes Ptéridologiques* 4: 101 (1917). HOLOTYPE: NORTHERN TERRITORY: Port Darwin, *Holtze 199*, 1882 (P).

ILLUSTRATIONS: Quirk & Chambers (1978: Figures 3c, 5a, b); Quirk et al. (1983: Figures 8 [holotype], 9, 35); Andrews (1990: Figure 34.4B).

*Fronde*s to 55 cm long and 12 cm wide. *Stipe* dark brown, glabrous or with sparse to dense short hairs and very sparse scales. *Rhachis* colour as for stipe, with moderately dense to dense short to medium length hairs (2–5 cells long) and very sparse long hairs and scales. *Lamina* deltoid, elliptic or ovate, quadripinnate or tripinnate at base, bipinnate for most of its length. *Larger pinnae* deltoid. *Pinnules* obtuse or somewhat acute, ovate, obovate, or oblong, final pinnules sometimes slightly caudate, margins slightly crenate, upper surface with sparse to dense minute rigid or short (1–3 cells long) acute hairs, which if minute and rigid may be conspicuous as outgrowths of margins, lower surface with sparse to moderately dense hairs (2–5 cells long) densest along midrib, or with dense minute rigid hairs (Figures 2b; 14a,b). *Spores* tetrahedral or rounded-tetrahedral, with varying amounts of reticulate-echinate ornamentation, granulose and trilete beneath ornamentation, 33–50 µm diam., 32 per sporangium (Figure 6f).

DISTRIBUTION AND HABITAT: Occurs in coastal regions of northern Australia, from Western Australia to Queensland (Figure 11f). Found in rocky monsoonal forested areas. Recorded also in southern India, Malaysia, Macao and New Guinea.

NOTES: *Cheilanthes contigua* is most easily confused with *C. tenuifolia* and several specimens are difficult to place. Their distributions overlap but *C. contigua* has a more

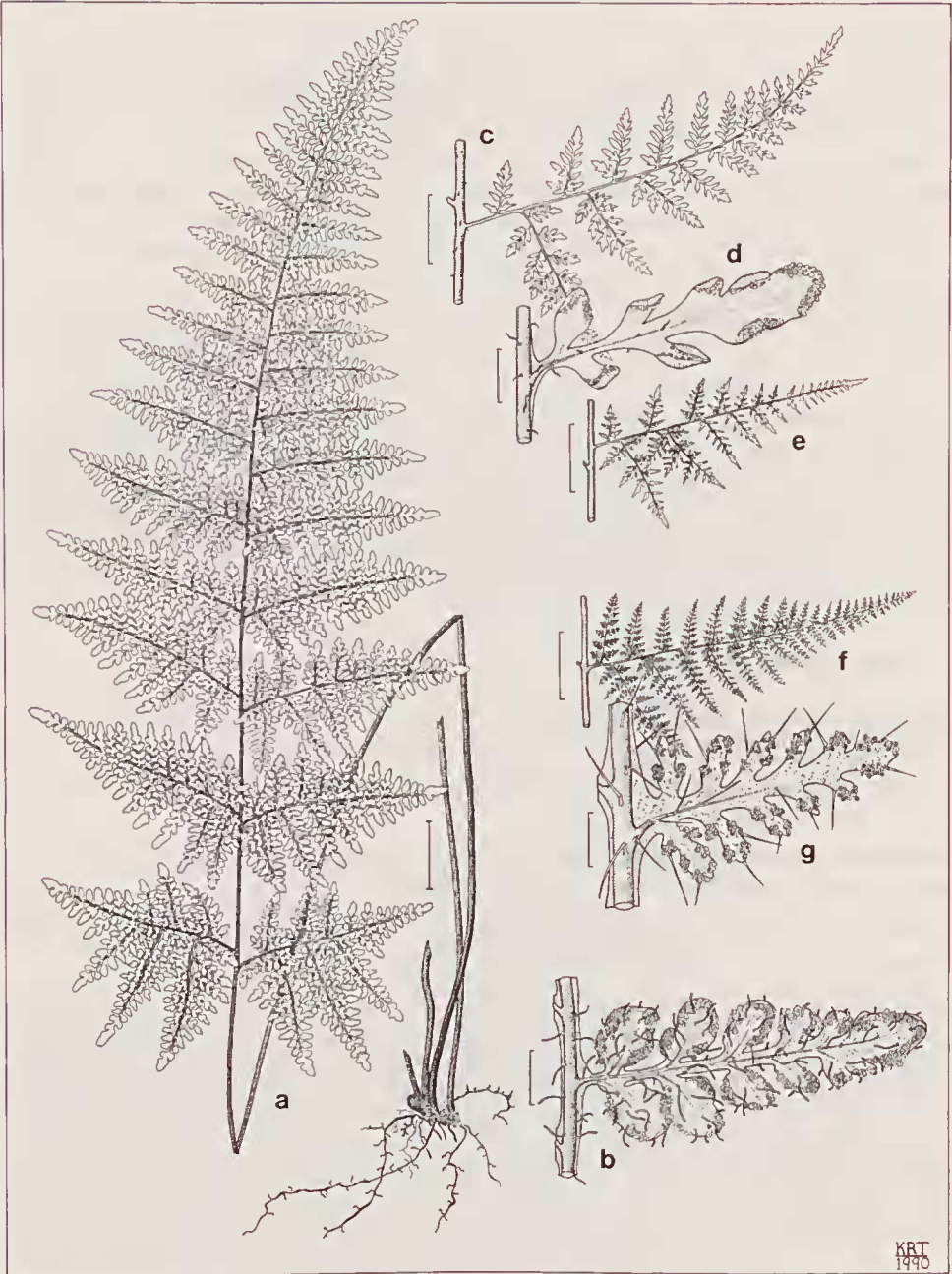


Figure 14. a,b, *C. contigua*: a habit, scale bar = 2 cm; b first pinnule from lowermost pinna, scale bar = 2 mm (Jacobs 5475 & Clarkson). c-e, *C. tenuifolia*: c pinna, scale bar = 2 cm; d first pinnule of lowermost pinna, scale bar = 2 mm; e pinna, scale bar = 2 cm (c,d: Jones 1756; e: Blake 21717). f,g, *C. fragillima*: f pinna, scale bar = 2 cm; g first pinnule from lowermost pinna, scale bar = 2 mm (W. Bishop 625 & K. Bishop).

westerly distribution into northern Western Australia. The two species have identical spore morphology (Figure 6c,d,f; Quirk et al. 1983: Figures 32, 35). *Cheilanthes contigua* differs from *C. tenuifolia* in having a denser cover of short hairs on the rachis, rhachillas, upper pinnule surface and midribs of lower pinnule surface (Figure 9c); its pinnules are more frequently obovate and obtuse and its fronds usually have more widely separated pinnae and more crowded pinnules than those of *C. tenuifolia*.

Cheilanthes contigua is distinguished from *C. prenticei* primarily by its morphology, also by its hair cover. *Cheilanthes contigua* has finely divided fronds with short obtuse non-caudate pinnules whereas *C. prenticei* is usually bipinnate with linear-oblong or narrow deltoid pinnules, which are somewhat caudate at the frond extremities. The hairs on *C. contigua* pinnules are minute or short and usually denser on the upper than the lower surface (usually confined to the midribs of lower surface) whereas those of *C. prenticei* are longer and they are denser on the lower pinnule surface and along the pinnule margins.

SELECTED SPECIMENS: WESTERN AUSTRALIA: Mt Bell in Leopold Ranges, Kimberley, A.S. George 15145, June 1978 (NSW, PERTH). NORTHERN TERRITORY: Nightcliff district, 7 km NE of Darwin, A. Rodd, Dec 1964 (NSW). QUEENSLAND: 3.7 km E of the Aurukun-Beagle North Camp road, J.R. Clarkson 4525, June 1982 (BRI, NSW); Garraway Ck, Iron Range road, S. Jacobs 5475 & J. Clarkson, Aug 1987 (NSW); Cape Melville Range, Bathurst Bay, S. Jacobs 5390 & J. Clarkson, July 1987 (NSW); Iter. Aust., R. Brown, 1802-1805 (NSW).

6. *Cheilanthes fragillima* F. Mueller, Fragm. 5: 123 (1866).

REPLACED NAME: *Notholaena fragilis* Hooker, Sp. Fil. 5: 114, t. 287A (1864). Non *Cheilanthes fragilis* Hooker (1859).

LECTOTYPE (Quirk et al. 1983: 523): NORTHERN TERRITORY: Fitzmaurice River, F. Mueller, Oct 1855 (MEL 503529).

ILLUSTRATIONS: Hooker (1864: t. 287A); Quirk et al. (1983: Figures 14, 15, 38, 39). Andrews (1990: Figure 34.1F).

Fronds to 32 cm long and 14 cm wide. Stipe dark brown, glabrous. Rachis colour as for stipe, with sparse to moderately dense straight white acute hairs (1-3 cells long). Lamina deltoid or ovate, quadripinnate or tripinnate at base, tripinnatifid or bipinnate for most of its length. Larger pinnae deltoid. Pinnules obtuse, oblong-ovate, margins deeply lobed, upper and lower surfaces with sparse long (1-3 mm) robust straight acute white hairs (1-3 cells long) especially conspicuous along margins (Figures 2c; 14f,g). Spores rounded-tetrahedral, varying amounts of reticulate-echinate ornamentation, granulose and trilete beneath ornamentation, 41-50 µm diam., 32 per sporangium (Figure 6e).

DISTRIBUTION AND HABITAT: Occurs in coastal areas of northern Australia, from the Kimberley region of Western Australia to Arnhem Land, Northern Territory (Figure 11g). Found in rock crevices or on skeletal soils on hillsides and ridges in tropical monsoonal regions.

NOTES: Although the location of Hooker's original specimen is not known, this species can be easily identified from the illustration accompanying his original description of *Notholaena fragilis* (Hooker 1864: t. 287A). This illustration also matches well with Mueller's type at MEL (listed by Quirk et al. (1983) as holotype, but actually a lectotype) and indicates that both Hooker and Mueller were referring to the same species and probably the same plant. Hooker was unsure whether the species belonged in the genus *Notholaena* or in *Cheilanthes*. In placing it in *Cheilanthes*, Mueller could not use *fragilis* as this epithet had already been applied to a different species from China.

Luerssen (1882) mistakenly applied the name *C. fragilis* to *C. fragillima* in comparing it with his new Thursday Island species, *C. prenticei*.

We include under *Cheilanthes fragillima* several Northern Territory specimens (from Melville Island, Bathurst Island and Arnhem Land) that have typical *C. fragillima*-like hairs on the rhachillas and on the midribs of the lower pinnule surface, but have short dense *C. contigua*-like hairs on the upper pinnule surface and rhachises. Morphologically they appear to be uncommon intermediates between the two species. They are probably hybrids, though we have no evidence, such as aborted spores, for this. It should be noted that both the spore size range of 22–25 µm diam. and the number of spores per sporangium (16) given by Quirk et al. (1983: 525) for *C. fragillima* are incorrect, although the spore micrograph scale gives the correct spore size (Quirk et al. 1983, Figures 38 & 39). We found that *C. fragillima* has 32 spores per sporangium and a spore size range of 41–50 µm diam. ($n=5$) (Figure 6e).

SELECTED SPECIMENS: WESTERN AUSTRALIA: N. Kimberley, Carson River Escarpment near Larryoo, E.A. Chesterfield 449, June 1984 (AD). NORTHERN TERRITORY: Deaf Adder Gorge, C. Dunlop 4445, Feb 1977 (DNA, NSW); East Alligator River near Cahills Crossing, R. Pullen 9443, June 1974 (DNA, NSW); creek descending escarpment Mt Brockman Outlier E. Jabiru, W. Bishop 625 & K. Bishop, Mar 1985 (NSW).

7. *Cheilanthes caudata* R. Brown, Prodr. Fl. Nov. Holl.: 156 (1810).

HOLOTYPE (Quirk et al. 1983: Figure 28): QUEENSLAND: Port II [Port Clinton], R. Brown, 1802–5 (BM).

SYNONYMY: *Cheilanthes tenuifolia* subsp. *caudata* (R. Brown) Domin, Biblioth. Bot. 85: 144 (1915). *Cheilanthes caudata* var. *caudata* (R. Brown) S.B. Andrews, Ferns of Queensland: 330 (1990). HOLOTYPE: as for *C. caudata*.

Cheilanthes tenuifolia subsp. *caudata* var. *diversiloba* Domin, Biblioth. Bot. 85: 144 (1915). LECTOTYPE (here chosen): QUEENSLAND: Picnic Hill, Russel [Russell] R., K. Domin 299, 1910 (PR).

C. pinnatifida D.L. Jones, Austrobaileya 2: 472 (1988). HOLOTYPE: NORTHERN TERRITORY: Arnhem Land, Lightning Dreaming, D.L. Jones 1478 (DNA). ISOTYPES: BRI, CANB, MEL.

ILLUSTRATIONS: Quirk et al. (1983: Figures 28 [holotype], 29, 46); Andrews (1990: Figure 34.1A [as *C. caudata* var. *caudata*]).

*Fronde*s to 64 cm long and 16 cm wide. *Stipe* and *rhachis* red-brown to black, glabrous or with sparse hairs (1–15 cells long). *Lamina* ovate or deltoid, tripinnate or sometimes quadripinnatifid at base, bipinnate for most of its length. *Larger pinnae* deltoid-ovate. *Pinnules* obtuse, linear, oblong, lanceolate or rarely ovate, margins slightly crenate, final pinnules incised at base and caudate at apex, upper and lower surfaces glabrous or with sparse short or minute hairs, often along the midrib (Figures 2d; 15a,b). *Spores* with varying amounts of echinate ornamentation, either tetrahedral, trilete, 32–48 µm diam., 32 per sporangium (Figures 6g,h), or spherical, 51–60 µm diam., 16 per sporangium (Figure 6h).

DISTRIBUTION AND HABITAT: Occurs in areas inland from the northern Australian coast from the Kimberley region of Western Australia, where it is rare and large-fronded, to the Northern Territory, and the eastern coastal Cape York region of Queensland (Figure 11h). Possibly extending to New Caledonia (see C.N. Page 4340 [BM]). Found in rock crevices or on rocky ground in open forest.

NOTES: *Cheilanthes caudata* is a distinctive species, but shows a considerable degree of variation, even on the type sheet (Quirk et al. 1983: Figure 28). Specimens at the limits of the species' morphological range may be confused with several other, possibly

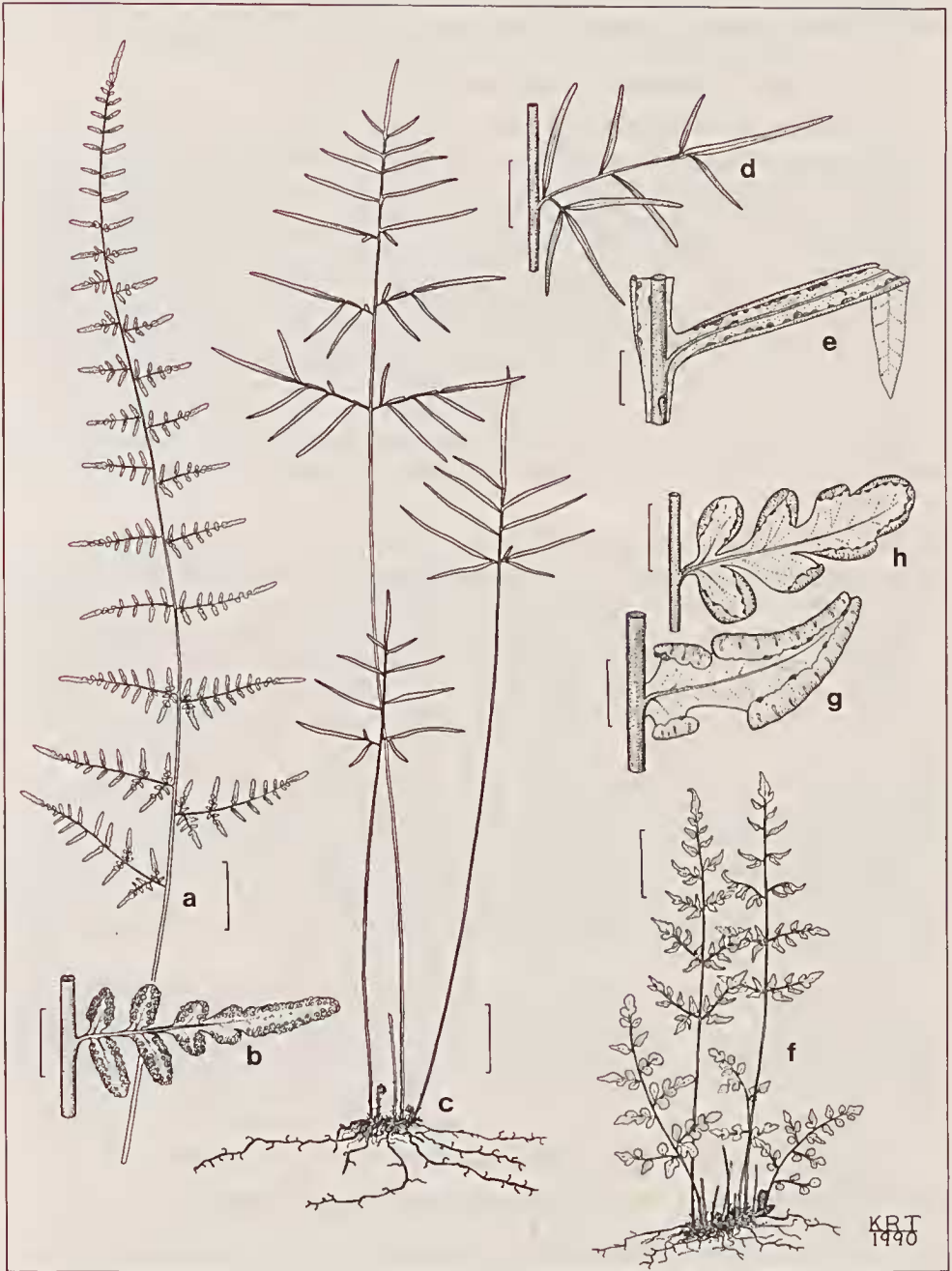


Figure 15. a,b, *C. caudata*: a frond, scale bar = 2 cm; b lowermost pinnule, scale bar = 5 mm (Jones 1549). c-e, *C. nitida*: c habit, scale bar = 2 cm; d lower pinna, scale bar = 1 cm; e lowermost pinnule, scale bar = 2 mm (c, e: Jones 1407; d: Domin 308 (PR)). f-h, *C. adiantoides*: f habit, scale bar = 2 cm; g lowermost pinnule, scale bar = 2 mm; h lowermost pinnule, scale bar = 5 mm (f,g: Tindale 2709; h: Salasoo 337).

related, species. *Cheilanthes caudata* is most easily confused with *C. nitida* but the two are separated on the degree of frond division and pinnule shape: *C. nitida* is bipinnate with extremely elongated, linear pinnules (see Quirk et al. 1983: Figures 30 and 31 [as *C. tenuissima*]). While possibly closely related to *C. contigua* and *C. prenticei*, *C. caudata* lacks the pubescent rachises and pinnules of these species.

The typical *Cheilanthes caudata* is glabrous, with 32 spores per sporangium, and the final pinnules are elongated and linear with incised bases (Quirk et al. 1983: Figure 29). Under *C. caudata* we now include the single specimen referred to *Cheilanthes* sp. by Quirk et al. (1983: 547) as well as all other glabrous, caudate specimens. We also include several specimens from Queensland that have 16 spores per sporangium and very sparse hairs but are otherwise indistinguishable from the specimens with 32 spores. *Domin 299* and *310* (*Cheilanthes tenuifolia* subsp. *caudata* var. *diversiloba* Domin) are in this group. On the scatter diagrams (Figure 9d) the 16-spored specimens of *C. caudata* mostly fit into the range of the 32-spored specimens, except that they tend to have denser hairs on the pinnule surfaces; the type (32-spored) falls in the overlapping area. The 16-spored forms may be hybrids of *C. caudata* with another species, perhaps *C. hirsuta*, since the spores are sometimes echinate like those of *C. hirsuta* (Figure 8e; Quirk et al. 1983: Figure 44); cytological evidence would be needed to substantiate this.

We include *Cheilanthes pinnaatifida* D.L. Jones under *C. caudata*. Comparison of over 20 vegetative and reproductive characters of the types of *C. caudata* (*R. Brown 78*) and *C. pinnaatifida* (*D.L. Jones 1478*) indicates very close similarity of the two and no marked character disjunctions. A spore of the type of *C. pinnaatifida* is shown in Figure 6g. The two types cannot be distinguished by stipe colour, a character Jones (1988) suggests is useful for distinguishing the species. The *C. pinnaatifida* type is almost identical to the topmost frond on the *C. caudata* type sheet, from which it differs only in the degree of division (tripinnatifid rather than tripinnate). Other specimens cited by Jones (1988) for *C. pinnaatifida* are tripinnate (for example, *Dunlop 5284*). We cannot therefore agree with Jones' statement that *C. pinnaatifida* is more like *C. nitida* than *C. caudata* since we believe that *C. pinnaatifida* and *C. caudata* are the same species. Jones (1988) suggests that *C. pinnaatifida* differs from *C. nitida* in the extent of frond division and pinnule length; the same differences separate *C. caudata* from *C. nitida*. Jones (1988) also draws attention to the distinctive lobing which precedes the apical cauda on most pinnae of *C. pinnaatifida*; this is also true for *C. caudata*.

SELECTED SPECIMENS: NORTHERN TERRITORY: 3 km SE Jim Jim Falls, Arnhem Land, *D.L. Jones 1521*, Mar 1984 (AD, BRI, CANB, DNA, MEL, NSW, PERTH); headwaters of East Alligator River, *D.L. Jones 1549*, Mar 1984 (AD, NSW). QUEENSLAND: 3.3 km S of Fairview, *J.R. Clarkson 3208*, Apr 1980 (BRI); Tinaroo Creek road, at crossing of Douglas Creek, 10.5 km SE of Mareeba, *A. & R. Tryon 7344*, Aug 1983 (NSW).

8. *Cheilanthes nitida* (*R. Brown*) *P.S. Green*, Kew Bull. 43: 653 (1988).

BASEONYM: *Pteris nitida* *R. Brown*, Prodr. Fl. Nov. Holl.: 155 (1810).

HOLOTYPE: NORTHERN AUSTRALIA: Tropical Australia, *R. Brown s.n.* (not traced). NEOTYPE (*Green 1988*): NORTHERN TERRITORY: Port Darwin, *Schultz 796* (K).

SYNONYMY: *Pellaea nitida* (*R. Br.*) *Baker* in *Hooker & Baker*, Syn. Fil.: 478 (1874). TYPE: as for *Pteris nitida*.

Acrostichum pteroides *R. Brown*, Prodr. Fl. Nov. Holl.: 145 (1810). *Neurosoria pteroides* (*R. Brown*) *Mettenius*, Bot. Zeitung (Berlin) 27: 438 (1869). Non *Cheilanthes pteroides* *Swartz* (1806). HOLOTYPE: NORTHERN AUSTRALIA: North Coast Island, *R. Brown 3* (BM).

Cheilanthes tenuissima Bailey, Queensl. Agric. J. 17: 28, t. 3 (1906). *Cheilanthes tenuifolia* subsp. *caudata* var. *tenuissima* (Bailey) Domin, Biblioth. Bot. 85: 144 (1915). *Cheilanthes caudata* var. *tenuissima* (Bailey) S.B. Andrews, Ferns of Queensland: 330 (1990). HOLOTYPE: QUEENSLAND: Islands of Torres Strait, *T. Tate s.n.* (BRI 18855).

ILLUSTRATIONS: Quirk et al. (1983: Figures 30 [incorrectly labelled as holotype], 31, 47 [as *C. tenuissima*]); Andrews (1990: Figure 34.1B [as *C. caudata* var. *tenuissima*]).

*Fron*ds to 34 cm long and 12 cm wide. *Stipe* and *rhachis* dark brown to black, glabrous or with sparse or, rarely, moderately dense, hairs (2–6 cells long, sometimes longer). *Lamina* ovate or oblong, bipinnate at base (the innermost basal pinnule may be trifoliolate) and for most of its length. *Larger pinnae* deltoid. *Pinnules* somewhat acute, narrow, linear, at least ten times longer than broad, margins entire or, rarely, lobed, upper surface glabrous or, rarely, with dense minute rigid hairs (Figures 3a; 15c–e), lower surface glabrous or with short hairs on midrib. *Spores* tetrahedral, with varying amounts of echinate ornamentation, granulose and trilete beneath ornamentation, 36–47 µm diam., 32 per sporangium (Figure 7c).

DISTRIBUTION AND HABITAT: Occurs in coastal areas of northern Australia from Northern Territory to Cape York Peninsula, Queensland (Figure 12a). Found in rocky or shallow soil in open forest areas.

NOTES: Robert Brown (1810) named this species *Acrostichum pteroides*. It was then moved to become the only species of *Neurosoria*, a genus created by Mettenius in 1869. Copeland (1947) recognized its close affinity with *Cheilanthes caudata*, which has fronds that are always tripinnate below. However, we believe that the species is clearly distinguishable from *C. caudata* and that the species (*A. pteroides*) and the genus *Neurosoria* both belong in *Cheilanthes*. As Green (1988) points out, the epithet *pteroides* cannot be used for this species because of Swartz's quite different *Cheilanthes pteroides* dating from 1806.

We are accepting that *Pteris nitida* R. Br. is synonymous with (and the basionym of) *Pellaea nitida* Baker, although the question cannot be resolved finally until the missing Brown type specimen (from tropical Australia) is located. As pointed out by Green (1988), the correct name and citation for the species in the meantime should be *Cheilanthes nitida* (R. Br.) P.S. Green. Green (1988) has chosen one of the two specimens that Baker (1874) cited (which are conspecific with Bailey's) as neotype of *Pteris nitida*.

Cheilanthes nitida is very close to *C. caudata*, from which it differs mainly in the extent of frond division (Figure 9d) and the length of the pinnules; hair characters can also distinguish the two species (Figure 9d). An apparent overlap in the first scatter diagram (for frond division) occurs due to the trifoliolate nature of the innermost pinnules of the lowest pinnae of *C. nitida*. In practice such specimens are easy to distinguish from the occasional bipinnate or tripinnatifid specimen of *C. caudata*.

Although the two species are usually easy to separate, one specimen 'found growing with [the] holotype of *C. tenuissima*' by Tate in the islands of Torres Strait (BRI 224919) is almost intermediate in form between the two, and it may well be a hybrid. We have seen only a single specimen of *C. nitida* that is tripinnate at the base (DNA 13392). Some *C. nitida* plants have relatively broad pinnules and may be difficult to separate from *C. tenuifolia* and *C. praetermissa* (for example, DNA 11562). *Cheilanthes nitida* is usually glabrous or nearly so; we have seen one specimen with dense minute rigid hairs on the upper pinnule surface (DNA 26665) and one specimen with hairy stipe and rhachis (DNA 29593).

SELECTED SPECIMENS: NORTHERN TERRITORY: Kapalga, *D.L. Jones* 1407, Feb 1984 (AD, BRI, CANB, DNA, MEL, NSW, PERTH). QUEENSLAND: Tozers Gap, *S. Jacobs* 5473 & *J. Clarkson*, Aug 1987 (NSW); Speewah Upper Clohesy R., *L.J. Brass* 18244, Mar 1948 (BRI); Gorge Creek, 10 miles [16 kms] W of Mareeba, *H.S. McKee* 9271, Apr 1972 (NSW); Yarraba [Yarrabah], *Domin* 308, 1909-1910 (PR).

9. *Cheilanthes praetermissa* *D.L. Jones*, *Austrobaileya* 2(5): 472 (1988).

HOLOTYPE: NORTHERN TERRITORY: Arnhem Land, near Mt Howship, East Alligator River Area, *D.L. Jones* 1443, Feb 1984 (DNA). ISOTYPES: BRI, CANB, MEL.

ILLUSTRATIONS: *D. Jones* (1988: Figure 2C,D [drawn from type]).

*Fronde*s to 26 cm long and 8 cm wide. *Stipe* and *rhachis* dark red-brown, glabrous or with sparse scales and sparse hairs of varying lengths. *Lamina* deltoid, bipinnate to tripinnatifid at the base, bipinnatifid for most of its length. *Larger pinnae* deltoid. *Pinnules* obtuse or acute, linear-oblong or linear-deltoid, broader and rounded for lower pinnae or sterile fronds, final pinnules sometimes slightly caudate, margins entire or lobed, upper surface glabrous or with sparse short hairs, lower surface glabrous or with sparse short to medium length hairs densest on midribs (Figures 3b; 16c,d). *Spores* rounded-tetrahedral, with sparse reticulate-echinate ornamentation, granulose and trilete beneath ornamentation, 33–45 µm diam., 32 per sporangium (Figure 7a,b).

DISTRIBUTION AND HABITAT: Occurs in northern Northern Territory (Figure 12b). Found in rocky areas of open forest in sandy or gravelly soil.

NOTES: The holotype of *Cheilanthes praetermissa* is not glabrous as described by Jones (1988); the upper pinnule surface has small multicellular acute hairs, and the lower pinnule surface has sparser small-medium length hairs, some of which have glandular tips; the rhachis and stipe have sparse hairs of various lengths.

Although Jones (1988) states that *C. praetermissa* is similar in general form to *C. nudiuscula*, we know of only three specimens of the latter and these are now placed in either *C. hirsuta* (the type of *C. nudiuscula*, *Brown* 60) or *C. prenticei* (BRI 226376 [2 specimens, formerly BRI 218826 and BRI 087848]).

Cheilanthes praetermissa is most easily confused with *C. pumilio* and occurs within its geographic range. The two are similar in degree of frond division and stipe and rhachis hair density, but pubescent specimens of *C. pumilio* have denser hairs on the pinnules than pubescent specimens of *C. praetermissa* (Figure 10a). The two species, especially the more easily confused glabrous specimens, can usually be separated on the basis of frond texture: *C. pumilio* fronds are membranous whereas those of *C. praetermissa* are leathery. *Cheilanthes praetermissa* has 32 spores that are similar to, but not as ornamented as, those of the 32-spored specimens of *C. pumilio* (Figure 7d-f; Quirk et al. 1983: Figure 43).

Pubescent specimens of *Cheilanthes praetermissa* may be confused with *C. contigua*. *C. praetermissa* is recognised by its coarser, leathery fronds and by the shape of its pinnules; the pinnules are elongate and usually taper evenly, whereas those of *C. pumilio* and *C. contigua* are usually shorter with more rounded ends. *Cheilanthes praetermissa* also has pinnule midribs noticeably dark for up to two-thirds of the pinnule length, immersed veins (except at the pinnule margins) and the lowest pair of pinnae very unequally basiscopically divided.

SELECTED SPECIMENS: NORTHERN TERRITORY: Lightning Dreaming, Arnhem Land, *D.L. Jones* 1490, Feb 1984 (BRI, CANB, DNA); East Alligator River area near Mt Howship, Arnhem Land, *D.L. Jones* 1435, Feb 1984 (BRI, CANB, DNA, MEL); Twin Falls, *C. Dunlop* 6674 & *J. Taylor*, Mar 1982 (DNA);

near Mount Basedow, c. 16.5 miles [26 km] SSE of Nourlangie Safari Camp, *M. Lazarides* 7876, Feb 1973 (DNA, NSW); base of Koongarra Saddle, Kakadu N.P., *M. Tindale* 10040 & *P. Munns*, July 1989 (NSW).

10. *Cheilanthes pumilio* (R. Brown) F. Mueller, Syst. Census Austral. Pl.: 138 (1882).

BASIONYM: *Notholaena pumilio* R. Brown, Prodr. Fl. Nov. Holl.: 146 (1810). [*Pteris pumilio* Banks & Solander, ined.]

HOLOTYPE: QUEENSLAND: Endeavour River, *Banks & Solander*, 1770 (BM, photo seen; fragment of holotype: NSW 192292).

SYNONYMY: *Cheilanthes tenuifolia* subsp. *nudiuscula* f. *pumilio* (R. Brown) Domin, Biblioth. Bot. 85: 142 (1915) excluding *Domin* 316. HOLOTYPE: as for *Notholaena pumilio*.

Cheilanthes paucijuga Baker in Hooker & Baker, Syn. Fil.: 515 (1874). HOLOTYPE: NORTHERN TERRITORY: Port Darwin, *Schomburgk*, Oct 1859 (K, specimen seen by K. Wilson).

Cheilanthes cavernicola D.L. Jones, Austrobaileya 2: 469 (1988). HOLOTYPE: NORTHERN TERRITORY: Oenpelli area, Arnhem Land, *Henshall* 1951, 12 June 1978 (DNA). ISOTYPES: AD, BRI.

Cheilanthes dunlopii D.L. Jones, Austrobaileya 2: 470 (1988). HOLOTYPE: NORTHERN TERRITORY: Keep River National Park, *Dunlop* 5838, 3 Mar 1981 (DNA).

ILLUSTRATIONS: Quirk et al. (1983: Figures 22, 23, 43); Andrews (1990: Figure 34.1E).

*Fronde*s to 50 cm long and 15 cm wide. *Stipe* and *rhachis* dark brown or red-brown, glabrous or with sparse to moderately dense hairs and scales of varying lengths, some glandular. *Lamina* deltoid or ovate, pinnate, bipinnate, tripinnatifid or tripinnate at the base, bipinnatifid or pinnate for most of the length. *Larger pinnae* deltoid, ovate or lanceolate. *Pinnules* obtuse or acute, elliptic, oblong or deltoid, final pinnules sometimes slightly caudate, margins entire or lobed, not usually inrolled, upper and lower surfaces glabrous or with sparse to dense short to long slender or cottony hairs (1–7 cells long) densest at the margins or midribs (Figures 3c; 16g–i). *Spores* with echinate ornamentation, granulose beneath ornamentation, either rounded tetrahedral and trilete, 33–50 µm diam., 32 per sporangium (Figure 7d–f), or spherical, 50–68 µm diam., 16 per sporangium (Figure 7g,h).

DISTRIBUTION AND HABITAT: Occurs in far northern Australia, from Western Australia to Northern Territory and the Cape York region, Queensland (Figure 12c). Found in rocky mountainous habitats.

NOTES: *Cheilanthes pumilio* is easily distinguished by the membranous texture of its fronds; veins are clearly visible and hydathodes usually present. We now extend the range of variation considerably to include plants with a wide range of lamina and pinnule shapes and hair cover, with continuous or discrete sori, and robust specimens with frond division up to the tripinnate level. Some of these robust specimens have much greater frond and spore dimensions than the ranges published by Quirk et al. (1983: 533) and they have 16 spores per sporangium. The type material of *C. pumilio* is among these 16-spored forms. The 16-spored specimens fit within the range of the 32-spored specimens on the scatter diagrams (Figure 10a). However, the 16-spored specimens of *C. pumilio* tend to be rather robust (taller with more divided fronds), with fronds that are somewhat thicker than the 32-spored specimens, though still membranous and therefore easily distinguished from *C. hirsuta*. Either the 32-spored or 16-spored forms of *C. pumilio* may be hybrids of *C. pumilio* with another species.

Quirk et al. (1983) did not report the existence of 16-spored forms of *Cheilanthes pumilio*, probably because of the smaller number of specimens available to them. The spore size of 24 µm diam. given by Quirk et al. (1983: 533) seems to be incorrect: in this study we found the size range of spores to be 33–50 µm (32-spored forms) (Figure 7d–f) and 50–68 µm (16-spored forms) (Figure 7g,h). An unpublished photograph by Quirk et al. of a spore from the type of *C. pumilio* shows that it fits into the size range of the 16-spored form, and after examination of more spores from the type in this study (Figure 7g), we can confirm the absence of trilete marks on these spores.

Under *Cheilanthes pumilio* we include *C. dunlopii* and *C. cavernicola*, two species recently described by Jones (1988). Spores from the type specimens of both are shown in Figure 7. Known only from the type specimen, *C. dunlopii* fits into our widened description of *C. pumilio*. Specimens of *C. cavernicola*, though paler and more hairy than most specimens of *C. pumilio*, fall at one end of, but within, the morphological range of the species and we believe that their morphology can probably be attributed to their habitat (moist shallow caves).

Domin's material of *Cheilanthes tenuifolia* subsp. *nudiuscula* f. *pumilio* (Domin 316) has coarse hairs and leathery texture and belongs in *C. hirsuta*.

SELECTED SPECIMENS: WESTERN AUSTRALIA: 'Theda' Station, Kimberley district, I.R. Telford 6234 & G. Butler, June 1977 (CANB, NSW, PERTH); Kings Sound, W.W. Frogatt, 1888 (NSW). NORTHERN TERRITORY: 11 km SSW Bing Bong H.S., N.M. Henry 141, June 1971 (AD, DNA); Katherine Gorge, M.D. Tindale 6054, July 1979 (NSW); Katherine National Park, A. Wood R790396a, July 1979 (NSW); Mount Brockman Outlier, Kakadu National Park, J. Russell-Smith 8064 & D. Lucas, Apr 1989 (CANB, DNA, NSW); Darwin, H.S. McKee 8267, Jan 1961 (BRI, DNA, NSW). QUEENSLAND: 0.6 km E of Wenlock River, R. Coveny 7081a & P. Hind, Sep 1975 (NSW); 20 miles [32 km] NNW of Mount Isa, C.H. Gittins, May 1963 (NSW).

11. *Cheilanthes prenticei* Luerssen, Bot. Centralbl. 9(1): 442 (1882).

HOLOTYPE: QUEENSLAND: Thursday Island, *Prentice, Herb. Fil. Luerssen No. 10834*, 1881 (n.v., location unknown).

LECTOTYPE (here chosen): probable fragment of holotype, labelled '*Cheilanthes prenticei* Lssn, Thursday Island, Prentice Leg.': MEL 1562952.

ILLUSTRATIONS: Andrews (1990: Figures 34.1C, 34.3E).

Fronds to 29 cm long and 7 cm wide. *Stipe* dark brown to black, glabrous or with sparse to dense short hairs (2–3 cells long) and very sparse long hairs and scales. *Rhachis* colour as for stipe, with moderately dense to dense short to medium length hairs (3–5 cells long, occasionally to 14 cells long). *Lamina* elliptic, ovate or lanceolate, bipinnate, occasionally tripinnate, at the base, bipinnate for most of its length. *Larger pinnae* deltoid, ovate or lanceolate, lowermost with basiscopic half more developed than acroscopic. *Pinnules* somewhat acute, linear-oblong or narrow-deltoid, final pinnules sometimes slightly caudate, margins entire or lobed, upper surface glabrous or with sparse to moderately dense medium length acute hairs (2–3 cells long) conspicuous as marginal fringe, lower surface with moderately dense to very dense longer (c. 1 mm) hairs (Figures 3d; 16e,f). *Spores* rounded-tetrahedral, usually coarsely echinate, granulose and trilete beneath ornamentation, 35–45 µm diam., 32 per sporangium (Figure 8c,d).

DISTRIBUTION AND HABITAT: Occurs only in the Cape York region of northern Queensland and Thursday Island in the Torres Strait (Figure 12d). Found in shaded sandstone areas amongst shrubs.

NOTES: *Cheilanthes prenticei* is most easily confused with *C. contigua* and *C. hirsuta*. The fronds of *C. prenticei* are not as finely divided as those of *C. contigua*. *Cheilanthes*

prenticei has longer hairs than *C. contigua* and the hairs are denser on the lower pinnule surface than the upper surface and are conspicuous along the margins, which tend to turn under. *C. contigua* has sparser hairs on the lower pinnule surface (usually only on the midrib) than on the upper pinnule surface. Some specimens of *C. prenticei* are morphologically similar to *C. hirsuta*, although most specimens of *C. prenticei* can be identified by the much denser fringe of long hairs on the inrolled pinnule margins, the greater development of the basiscopic half of the lowermost pinnae and the darker colour of the rhachis.

Luerssen (1882) described *Cheilanthes prenticei* from a specimen collected by Prentice and sent to him by Mueller. This type specimen was lodged at Leipzig, and therefore may have been lost during the Second World War; we have been unable to locate it at any of the herbaria that house Luerssen's or Prentice's specimens. However, the lectotype (MEL 1562952), which we believe is probably a small fragment of the holotype, has almost glabrous upper pinnule surfaces, thus fitting Luerssen's description (1882) of *C. prenticei*. In the present study, several specimens from Thursday Island (the type locality) were examined. While a few have glabrous upper pinnule surfaces, most specimens have a sparse to moderately dense hair cover but otherwise match the fragment and protologue; hence we have widened the species description to accommodate the wider range of specimens now available.

SELECTED SPECIMENS: QUEENSLAND: Browns Creek, Pascoe River, L.J. Brass 19596, July 1948 (BRI); Herberton, coll. unknown, Jan 1912 (BRI 226376 [formerly BRI 218826 and BRI 087848]); Thursday Island, R.W. Coppinger, date unknown (BRI 314660 [formerly BRI 218711], NSW); Thursday Island, T. Tate, Oct 1905 (BRI, NSW); Cape York Peninsula, J.E. Young, July 1923 (BRI).

12. *Cheilanthes hirsuta* (Poiret) Mettenius, Abh. Senckenb. Naturf. Ges. 3: 69 (1859).

BASIONYM: *Pteris hirsuta* Poiret, Encycl. 5: 719 (1804).

HOLOTYPE: unknown locality and date, *P. Sonnerat* (P-LA, photo seen).

SYNONYMY: *Pteris nudiuscula* R. Brown, Prodr. Fl. Nov. Holl.: 155 (1810). *Cheilanthes nudiuscula* (R. Brown) T. Moore, Ind. Fil.: 249 (1860). *Cheilanthes tenuifolia* subsp. *nudiuscula* f. *glabrata* Domin, Biblioth. Bot. 85: 142 (1915). HOLOTYPE (Quirk et al. 1983: Figure 26): NORTHERN AUSTRALIA: Coast 'T' [Tropical: the coast of Queensland and the Northern Territory westward to Arnhem Bay], R. Brown 60, 1802–5 (BM).

C. tenuifolia subsp. *nudiuscula* f. *pubescens* Domin, Biblioth. Bot. 85: 142 (1915). LECTOTYPE (here chosen): QUEENSLAND: Picnic Hill, Russel [Russell] R., K. Domin 313 (PR).

ILLUSTRATIONS: Quirk et al. (1983: Figures 24, 25, 44 [as *C. hirsuta*], 26, 27, 45 [as *C. nudiuscula*]; Figures 26, 45 of holotype and spore of holotype respectively); Andrews (1990: Figure 34.3D, 34.4A; Figure 34.2A [as *C. nudiuscula*]).

*Fronde*s to 36 cm long and 5 cm wide. *Stipe* dark red-brown, glabrous or with sparse short stiff hairs (1–4 cells long) and very sparse scales. *Rhachis* colour as for *stipe*, with sparse to moderately dense hairs (usually short, occasionally to 14 cells long) and sparse scales. *Lamina* elliptic or lanceolate, bipinnate to tripinnate at the base, bipinnatifid for most of its length. *Larger pinnae* deltoid-ovate, lowermost with basiscopic and acroscopic halves equally developed. *Pinnules* obtuse or acute, oblong, triangular or deltoid, margins entire or lobed, upper surface occasionally glabrous, usually with sparse slender short to medium length hairs (1–4 cells long) densest at the margins, lower surface with sparse to dense medium to long hairs (Figures 4a; 16a,b). *Spores* spherical, with varying amounts of echinate ornamentation, granulose and ridged beneath ornamentation, 40–64 µm diam., 16 per sporangium (Figure 8e).

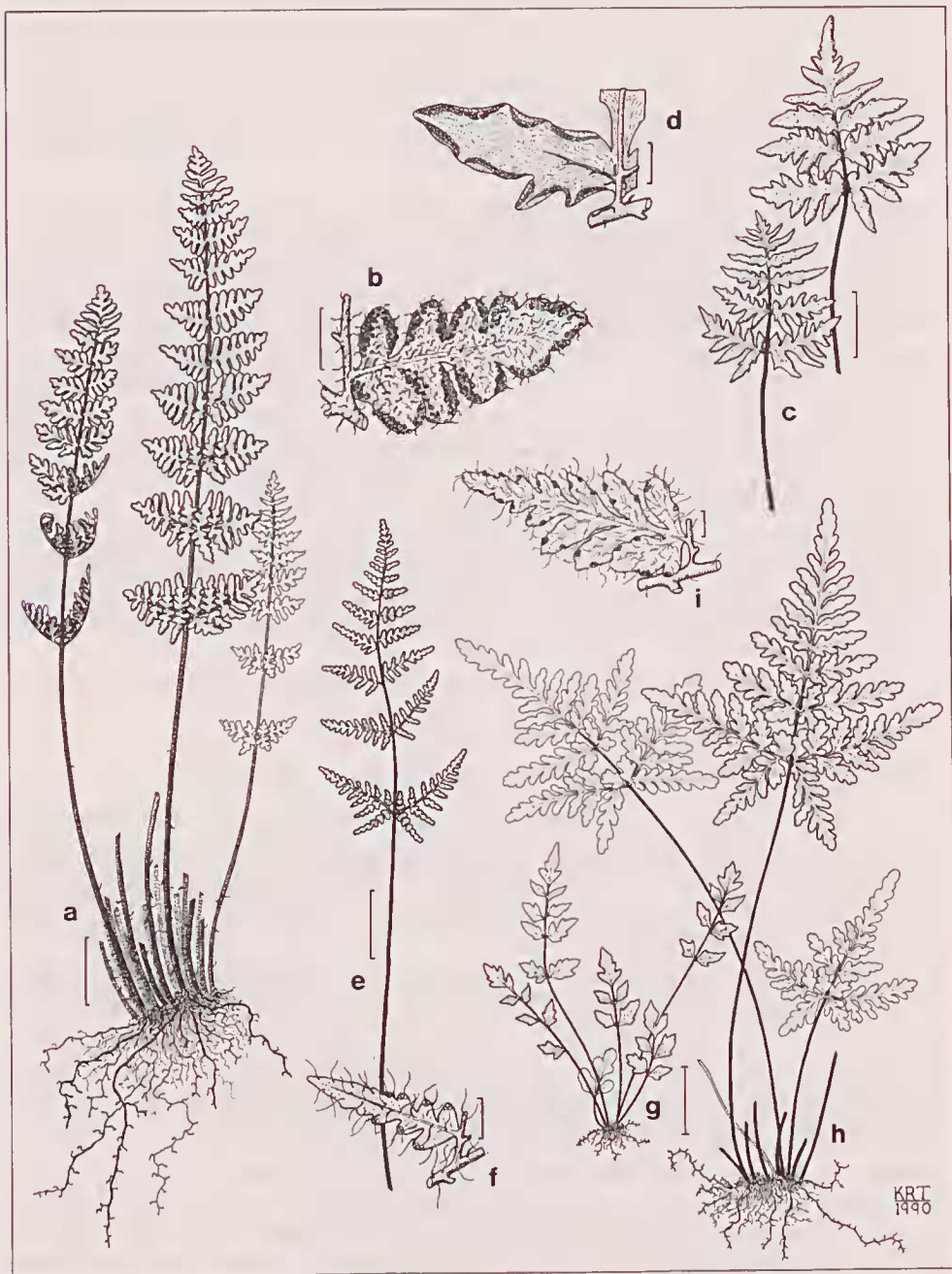


Figure 16. a,b, *C. hirsuta*: a habit, scale bar = 2 cm; b first pinnule of lowermost pinna, scale bar = 3 mm (Blaxell 519). c,d, *C. praetermissa*: c fronds, scale bar = 2 cm; d first pinnule of lowermost pinna, scale bar = 3 mm (Lazarides 7876). e,f, *C. prenticei*: e frond, scale bar = 2 cm; f first pinnule of lowermost pinna, scale bar = 3 mm (Brass 19596, BRI 4537). g-i, *C. pumilio*: g habit, scale bar = 2 cm; h habit of robust specimen, scale bar = 2 cm; i first pinnule of lowermost pinna, scale bar = 3 mm (g: Russell-Smith 8064 & Lucas; h,i: McKee 8267).

DISTRIBUTION AND HABITAT: Occurs mainly in coastal areas of eastern Queensland, more rarely in inland areas of northern Northern Territory and the Kimberley region of Western Australia (Figure 12e). Found on steep rocky exposed hillsides or in crevices of rocks or cliffs, often near a creek or gorge. Also occurs in Hong Kong, Timor, Philippines, New Caledonia and Fiji.

NOTES: The Australian specimens match the photo of the type and the descriptions of *Cheilanthes hirsuta* by both Desvaux (1813) and Mettenius (1869). After examining a wide range of specimens and the photograph of the type, we believe *C. hirsuta* in its hair and spore characters to be an extremely variable species, and we now include *C. nudiuscula* under *C. hirsuta* (see Quirk et al. 1983: Figures 24–27). The typical *C. hirsuta* is bipinnate; however, some specimens are tripinnate or tripinnatifid. Typically *C. hirsuta* has sparse medium length hairs on the upper pinnule surface and moderately dense hairs on the lower pinnule surface and rachis. The pinnules or pinnule lobes of *C. hirsuta* range from oblong and rounded to triangular or deltoid. *Cheilanthes hirsuta* has 16 spherical spores per sporangium and the spores are typically echinate (Figure 8e; Quirk et al. 1983: Figure 44); however, the amount of ornamentation is variable and some specimens have spores that are quite plain. The type of *Cheilanthes nudiuscula* is not of typical *C. hirsuta*, but fits into the range of variation, for both frond morphology (Quirk et al. 1983: Figure 26) and spore morphology (Quirk et al. 1983: Figure 45), as do Domin's specimens of *C. tenuifolia* subsp. *nudiuscula* f. *pubescens* (Domin 300, 313, 314, and 315) and *C. tenuifolia* subsp. *nudiuscula* f. *glabrata* (Domin 311, 312). Domin's specimen (316) of *C. tenuifolia* subsp. *nudiuscula* f. *pumilio* is also referable to *C. hirsuta*.

Cheilanthes hirsuta is most easily confused with *C. pumilio*, a species that is easy to recognise because of the thin membranous texture of its fronds. *Cheilanthes pumilio* usually has 32 spores per sporangium, whereas *C. hirsuta* has 16 spores per sporangium. However, some specimens of *C. pumilio*, including the type specimen, have 16 spores per sporangium. These 16-spored specimens of *C. pumilio* also sometimes have *C. hirsuta*-like hairs on the pinnules, though they are thin-textured like most collections of *C. pumilio*.

Cheilanthes hirsuta can also be confused with *C. prenticei*, a relatively rare species found only in far northern Queensland. *Cheilanthes prenticei* is recognisable by the very dense long hairs on the lower pinnule surface; the same type of hairs usually form a fringe along the pinnule margins. *C. prenticei* also has a darker rachis and the basiscopic halves of the lowermost pinnae are more developed than the acroscopic halves. While the two species are easily separated on morphological characters, including pinnule hair distribution (Figure 10b), their different spore numbers can also be useful: *C. hirsuta* has 16 spores per sporangium, whereas *C. prenticei* has 32.

SELECTED SPECIMENS: NORTHERN TERRITORY: 7 km NE of Mountain Valley H.S., D.J. Nelson 187, Apr 1962 (BRI, DNA). QUEENSLAND: Mareeba, S.T. Blake 9473, June 1935 (BRI); Trinity Bay, A.C. Beauglehole 3332, June 1955 (NSW); Tinaroo Creek road at Douglas Creek crossing, A. Tryon 7346 & R. Tryon, Aug 1983 (NSW); Valley of Lagoons H.S., Upper Burdekin River, D.F. Blaxell 519, May 1971 (NSW); S of Cooktown, Annan Gorge, S.T. Blake 23391, May 1970 (NSW).

13. *Cheilanthes brownii* (Kuhn) Domin, Biblioth. Bot. 85: 133 (1915).

BASIONYM: *Gymnogramme brownii* Kuhn, Analecta Pteridographica 9: 458 (1869).

HOLOTYPE (Quirk et al. 1983: Figure 18): NORTHERN TERRITORY: Arnheim [Arnhem] South Bay, Point U [Mount Caledon], R. Brown 5, 6 Feb 1803 (BM).

SYNONYM: *Notholaena vellea* R. Brown, Prodr. Fl. Nov. Holl.: 146 (1810). Non *Cheilanthes vellea* (Aiton) F. Mueller, Fragm. 5: 123 (1866).

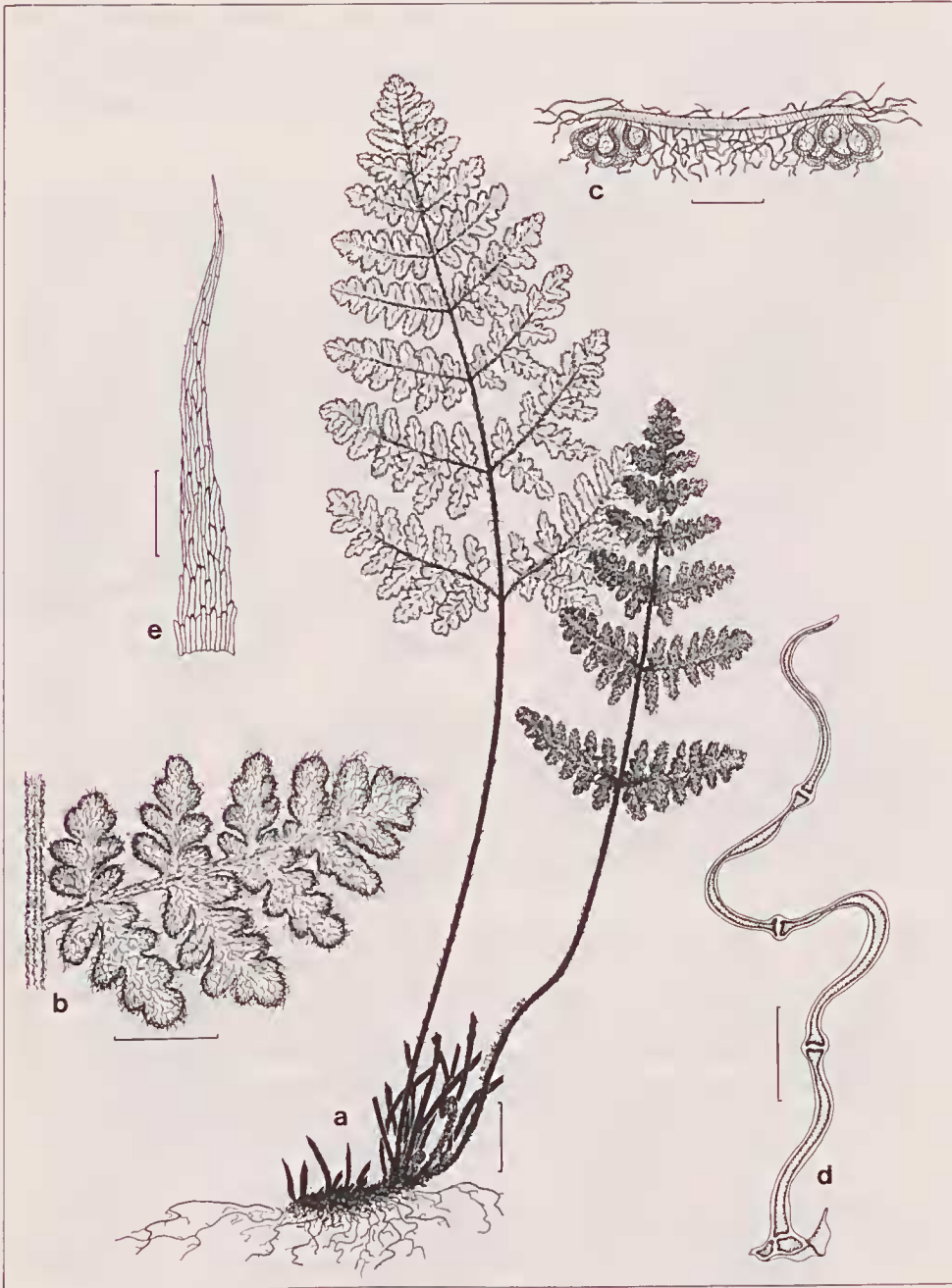


Figure 17. *C. brownii*: a habit, scale bar = 1 cm; b pinna upper surface, scale bar = 5 mm; c T.S. of fertile pinnule, scale bar = 0.5 mm; d hair from lower (abaxial) pinna surface, scale bar = 0.2 mm; e rhizome scale, scale bar = 0.5 mm (Beauglehole 47386 & Carr 3608).

[*Notholaena brownii* Desvaux, Prodr.: 220 (1827), nom. illeg.]

ILLUSTRATIONS: Quirk & Chambers (1978: Figures 9a, b [as *C. vellea*]); Quirk et al. (1983: Figures 18, 19, 41 [as *C. brownii*; Figure 18 of type]; Andrews (1990: Figure 34.2C).

*Fronde*s to 35 cm long and 5 cm wide. *Stipe* and *rhachis* dark brown to black, with sparse to dense long slender acute hairs (6 to 12 cells long), and very sparse scales. *Lamina* elliptic or lanceolate, bipinnate or tripinnate at base, bipinnate for most of its length. *Larger pinnae* narrow-deltoid. *Pinnules* rounded, deltoid, margins entire or lobed, upper surface with sparse to very dense long hairs, lower surface with extremely dense long hairs (Figures 4b; 17). *Spores* spherical, ornamented with varying amounts of globular or randomly branched deposits or, sometimes, echinate processes, smooth or granulose beneath ornamentation, either ridged, 47–71 µm diam., 16 per sporangium (Figure 8h), or trilete, 34–48 µm diam., 32 per sporangium (Figure 8f,g).

DISTRIBUTION AND HABITAT: Occurs in northern, central and south-western Australia, in Western Australia, Northern Territory and Queensland (Figure 12f). Found in soil pockets or rock crevices on wooded rocky hillsides or cliffs of arid and semi-arid areas.

NOTES: *Cheilanthes brownii* is distinguished from *C. sieberi* subsp. *pseudovellea* by its denser cover of hairs, which are not branched, twisted or glandular, and differs from *C. lasiophylla* in having simple rather than branched scales and hairs.

The presence of 32-spored as well as 16-spored forms of *Cheilanthes brownii* is reported here for the first time: the 32-spored plants are morphologically indistinguishable from the 16-spored specimens and fit into the range of the 16-spored specimens on the scatter diagrams (Figure 10c). Two unusual specimens with finely dissected fronds and with 32 spores, from Riversleigh near the Northern Territory – Queensland border, have also been placed in *C. brownii*. These may be hybrids of *C. brownii* with another species, perhaps *C. sieberi*, though we have no cytological evidence to confirm such a hypothesis.

Cheilanthes brownii can also be confused with very hairy specimens of *C. hirsuta* and *C. prenticei*; however, the two latter species characteristically have fringes of hairs on the pinnule margins, whereas *C. brownii* does not.

Green (1988) changed the authority of *Cheilanthes brownii* from (Desv.) Domin to (Kuhn) Domin. The change was based on the illegitimacy of the two names *Notholaena brownii* Desv. and *N. vellea* (Ait.) Desv. Domin (1915) had used the former as basionym for his new combination, *Cheilanthes brownii*, when he should have used *Gymnogramme brownii* Kuhn, which he had listed as a synonym.

SELECTED SPECIMENS: WESTERN AUSTRALIA: 18.5 km NW of Wongan Hills towards Piawaning, R.G. Coveny 7856 & B.R. Maslin, Aug 1976 (NSW, CANB); Wolf Creek Meteorite Crater, c. 85 km S of Halls Creek, Kimberleys, A.C. Beaglehole 47386 & G. Carr 3608, July 1974 (AD, PERTH); Wolf Creek Crater, B. Maloney 5, July 1977 (NSW). NORTHERN TERRITORY: 54 km S of Elliott, Stuart Highway, J. Must 471, Feb 1969 (DNA, NSW); 21 km W of 'Wollogorang H.S.' – 'Calvert Hills road', S. Jacobs 1567, May 1974 (NSW); Moline Rockhole, 9 km NE of Mary River on Pine Creek – El Sharana road, K.L. Wilson 5225, May 1983 (NSW). QUEENSLAND: Gorge Creek 18 km W of Mareeba, H.S. McKee 9263, Apr 1962 (BRI, NSW); Canopy Rock, Mountain Valley Station, R. Swinbourne 685, Feb 1963 (NSW).

14. *Cheilanthes lasiophylla* Pichi-Serm., *Webbia* 8: 209 (1951).

REPLACED NAME: *Notholaena canescens* Kunze, *Ind. Sem. Hort. Lips.* (1845); *Linnaea* 19: 406 (1847); *Lehmann, Pl. Preiss.* 2: 110 (1847). Non *Cheilanthes canescens* Kunze, *Linnaea* 13: 143 (1839).

LECTOTYPE (Pichi-Sermolli 1951): Jardin de Leipzig, raised by chance from spores brought from New Holland [Australia] by Preiss, 1846, Kunze (K, photo seen). ISOLECTOTYPES: G (photo seen); BR (n.v.).

[*Notholaena lasiopteris* F. Mueller, in Hooker, *Journ. Bot.* 5: 105 (1853), nom. nud.]

ILLUSTRATIONS: Pichi-Sermolli (1951: Figures 3–6 [figures of type specimens]); Quirk & Chambers (1978: Figures 8a–d); Quirk et al. (1983: Figures 20, 21, 42); Andrews (1990: Figure 34.2D).

*Fronde*s to 24 cm long and 3 cm wide. *Stipe* and *rhachis* red-brown to black, with moderately dense to dense scales that have dendritic basal edges. *Lamina* elliptic or lanceolate, bipinnate at the base and for most of its length. *Larger pinnae* deltoid-ovate. *Pinnules* obtuse, ovate-lanceolate, margins entire or lobed, upper surface with sparse to moderately dense slender white branched hairs, lower surface with dense hairs and very sparse scales (Figures 4c; 18). *Spores* spherical, with varying amounts of reticulate ornamentation, granulose and ridged beneath ornamentation, 45–74 µm diam., 16 per sporangium (Figure 8a). $2n =$ at least 105, Quirk et al. (1983: 531).

DISTRIBUTION AND HABITAT: Occurs in central and southern Australia from Western Australia to western New South Wales and north-western Victoria (Figure 12g). Found on rocky slopes and in rock crevices in arid inland mountain ranges or rock outcrops.

NOTES: *Cheilanthes lasiophylla* is easily distinguished from the scaly *C. distans* and the hairy *C. brownii* by the long hair-like branches that arise from the basal margins of the scales.

SELECTED SPECIMENS: WESTERN AUSTRALIA: Dundas Rocks, 18 km S of Norseman, A.C. Beaglehole 13153, Sep 1965 (NSW); 6 km S of Agnew, A.C. Beaglehole & E.G. Errey, Sep 1978 (MEL). NORTHERN TERRITORY: Lassiters Cave, Hull River, G. Chippendale 4615, June 1958 (DNA, NSW, PERTH); Penny Springs, George Gill Range, A.C. Beaglehole, July 1968 (MEL). SOUTH AUSTRALIA: Middle Flinders Range, Chambers Gorge near Mt Chambers, Hj. Eichler 12548, Sep 1956 (AD, NSW); Gammon Ranges, northern Flinders Range, Hj. Eichler, Sep 1956 (NSW); Flinders Range, N.F. Learmouth ACB 7568, Sep 1956 (NSW); Upper Arkaringa Valley, R. Helms, May 1891 (MEL, NSW). NEW SOUTH WALES: Girilambone, E. Betche, Oct 1886 (NSW); Tibbooburra, E.F. Constable, Oct 1949 (NSW). VICTORIA: 2 km N of Rockhole Bore, N of Murrayville, T.S. Henshall, Aug 1970 (BRI).

15. *Cheilanthes distans* (R. Brown) Mettenius, *Abh. Senckenb. Naturf. Ges.* 3: 69 (1859).

BASEONYM: *Notholaena distans* R. Brown, *Prodr. Fl. Nov. Holl.*: 146 (1810).

HOLOTYPE (Quirk et al. 1983: Figure 16): New South Wales: Port Jackson, R. Brown 4, 1802–5 (BM).

ILLUSTRATIONS: Quirk & Chambers (1978: Figures 7a–f); Quirk et al. (1983: Figures 16 [holotype], 17, 40); Andrews (1990: Figure 34.2B).

*Fronde*s to 30 cm long and 3 cm wide. *Stipe* red-brown or dark brown, moderately dense to dense brown scales and some hairs. *Rhachis* colour as for stipe, with dense scales. *Lamina* linear, bipinnate or bipinnatifid at the base and for most of its length. *Larger pinnae* deltoid-ovate. *Pinnules* obtuse, oblong-elliptic, margins entire or lobed, upper surface with sparse to moderately dense slender white hairs and very sparse scales, or occasionally glabrous, lower surface with sparse to dense scales and very sparse hairs (Figures 4d; 19). *Spores* spherical, echinate ornamentation, granulose and ridged beneath ornamentation, 43–79 µm diam., 16 per sporangium (Figure 8b).



Figure 18. *C. lasiophylla*: a habit, scale bar = 1 cm; b early season frond, scale bar = 1 cm; c frond, scale bar = 1 cm; d pinna upper surface, scale bar = 5 mm; e T.S. of fertile pinna, scale bar = 0.5 mm; f branched hair from lower (abaxial) pinnule surface, scale bar = 0.1 mm; g scale from base of stipe, scale bar = 1 mm (a,d,e,f,g: Helms, MEL 667615; b: Beaglehole, MEL 648284; c: Beaglehole & Errey, MEL 648276).

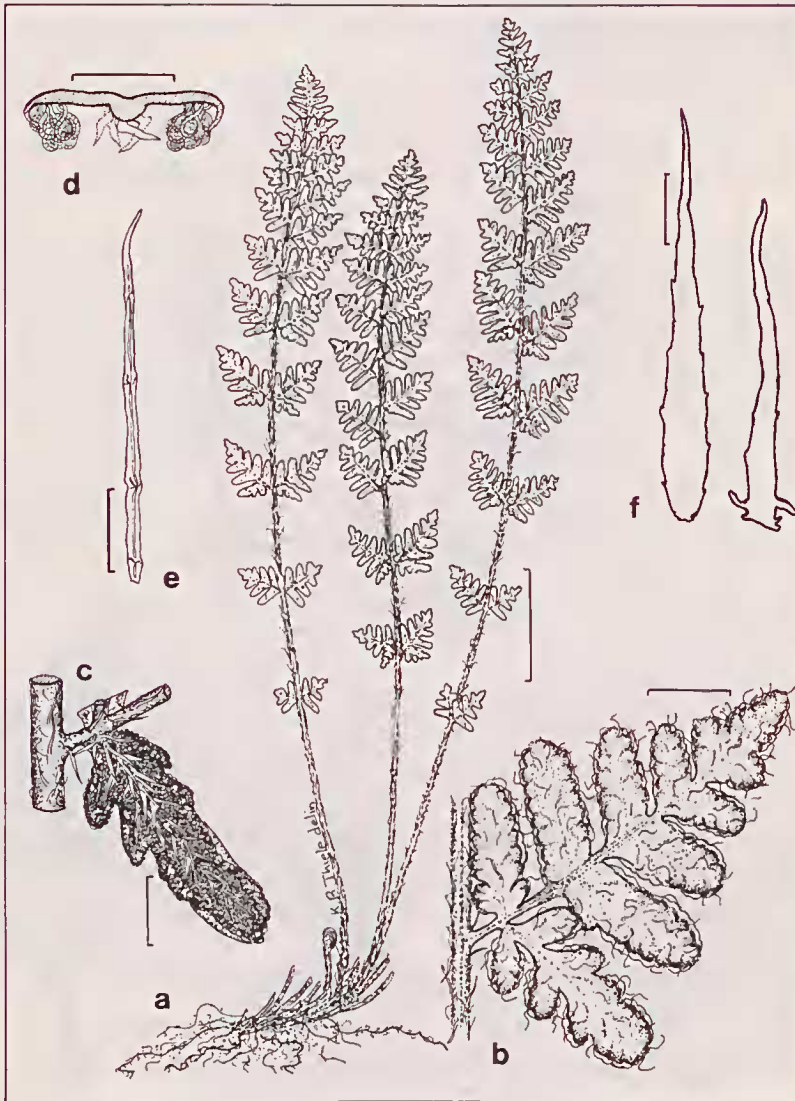


Figure 19. *C. distans*: a habit, scale bar = 2 cm; b pinna, upper (adaxial) surface, scale bar = 3 mm; c pinnule, lower (adaxial) surface, scale bar = 2 mm; d pinnule, T.S., scale bar = 1 mm; e hair from lower pinna surface, scale bar = 0.4 mm; f scales from mid-vein of pinna, scale bar = 0.5 mm (Willis, MEL 504710).

DISTRIBUTION AND HABITAT: Occurs in eastern Australia from Victoria (isolated occurrences) through New South Wales (abundant) to mid-northern Queensland; isolated specimens from South Australia and Western Australia; also occurs on Lord Howe Island (Figure 12h). Found in rock crevices in moderately wooded often mountainous areas. Extends to New Zealand, New Caledonia and some other Pacific islands.

NOTES: *Cheilanthes distans* is distinctive because of the simple, often coarse, scales on the lower surface (especially midrib) of the pinnae. It is most easily confused with *C. lasiophylla*, but *C. lasiophylla* has dense hairs on the lower pinnule surface and the scales on its stipe and rhachis have relatively long branches arising from their basal edges.

SELECTED SPECIMENS: WESTERN AUSTRALIA: 11.5 km N of Moora, R.J. Chinnock 5284, Oct 1981 (AD, NSW). SOUTH AUSTRALIA: Southern Flinders Ranges, Mambray Creek, P. Martinsen 0060, Sep 1974 (AD); Barossa Valley, R.J. Chinnock 204, July 1973 (NSW). QUEENSLAND: Mt Coolum c. 3 km S of Coolum Beach, P.R. Sharpe 3162, Feb 1982 (BRI, NSW); Valley of Lagoons H.S., Upper Burdekin River, D.F. Blaxell 522, May 1971 (NSW) [mixed collection with *C. brownii*]. NEW SOUTH WALES: Cattai Creek, Cattai, R. Coveny 8644 & S.K. Roy, Nov 1976 (NSW, CANB); Nandewar Mountains on Kaputar road, J.C. Morrow 42, Mar 1968 (NSW); 5-mile Creek, Mailmans Gap, Cocopara Nature Reserve, J.H. Willis, Oct 1969 (MEL). VICTORIA: 12 km from Dargo on Upper Dargo Road, H. Quirk 1, Feb 1975 (MEL).

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References

- Baker, J.G. (1874) *Cheilanthes* and *Pellaea*. Pp. 475–478 in W.J. Hooker & J.G. Baker (eds), *Synopsis Filicum*, 2nd edn.
- Brown, R. (1810) *Prodromus florae Novae Hollandiae et Insulae van-Diemen*.
- Christensen, C. (1906) *Index Filicum* (Hagerup: Copenhagen).
- Copeland, E.B. (1947) *Genera Filicum* (Chronica Botanica: Waltham, Mass., U.S.A.).
- Desvaux, A.N. (1813) Observations sur quelques nouveaux genres de fougères et sur plusieurs espèces nouvelles de la même famille. *J. Bot. Agric.* 1: 89–93.
- Domin, K. (1915) Beiträge zur Flora und Pflanzengeographie Australiens. *Bibliotheca Bot.* 85: 121–239.
- Green, P.S. (1988) Notes relating to Australian ferns, especially from Norfolk & Lord Howe Islands. *Kew Bull.* 43(4): 649–657.
- Hooker, W.J. (1864) *Species Filicum* vol. 5.
- Jones, D.L. (1988) New fern species from northern Australia. *Austrobaileya* 2: 469–480.

- Luerssen, C. (1882) Pteridologische notizen. *Bot. Centralbl.* 9: 442–443.
- Manton, I., & Sledge, W.A. (1954) Observations on the cytology and taxonomy of the pteridophyte flora of Ceylon. *Phil. Trans. Roy. Soc. London (B)* 238: 127–185.
- Mettenius, G. (1869) in M. Kuhn, *Analecta pteridographica. Bot. Zeitung (Berlin)* 27: 437–440.
- Mickel, J.T. (1987) A new fern from western Mexico and its bearing on the taxonomy of the Cheilantheid ferns. *Amer. Fern J.* 77(4): 109–114.
- Pichi-Sermolli, R.E.G. (1951) Notes on some Australian ferns. *Webbia* 8: 205–211.
- Pichi-Sermolli, R.E.G. (1970) A provisional catalogue of the family names of living pteridophytes. *Webbia* 25: 219–297.
- Pichi-Sermolli, R.E.G. (1977) Tentamen Pteridophytorum genera in taxonomicum ordinem redigendi. *Webbia* 31: 313–512.
- Quirk, H. & Chambers, T.C. (1978) Spore characters of the genus *Cheilanthes* with particular reference to southern Australia. *Fern. Gaz.* 11: 385–399.
- Quirk, H., Chambers, T.C. & Regan, M. (1983) The fern genus *Cheilanthes* in Australia. *Austral. J. Bot.* 31: 501–553.
- Rumphius, G.E. (1750) *Herbarium amboinense* vol. 6.
- Tryon, R.M. & Stolze, R.G. (1989) Pteridophyta of Peru. Part II. 13. Pteridaceae – 15. Dennstaedtiaceae. *Fieldiana, Bot., New Series* No. 22.
- Swartz, O. (1806) *Synopsis Filicum*.
- Walker, T.G. (1979) The Cytogenetics of Ferns. Pp. 87–132 in A.F. Dyer (ed.), *The Experimental Biology of Ferns* (Academic Press: London).

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